SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1905.

GENERAL PHYSICS.

1173. *Densities of Certain Gases and their Accuracy.* **A. Leduc.** (Comptes Rendus, 140. pp. 642–644, March 6, 1905.)—The author gives the following gaseous densities, referred to air containing 23·2 per cent. by weight of oxygen and under normal conditions [compare Abstract No. 63 (1898)] :—

	Found.	Calc.
Nitrous oxide	1·5301	1·5302
Sulphur dioxide	2·2639	2·2639
Chlorine	2·491	2·4918
Methane	—	0·5545

These values are in good agreement with numbers more recently determined by various investigators. T. H. P.

1174. *Compressibility of Gases between One Atmosphere and Half an Atmosphere of Pressure.* **Rayleigh.** (Roy. Soc., Phil. Trans. 204. pp. 351–372, April 6, 1905. Roy. Soc., Proc. 74. p. 446, Feb. 24, 1905. Abstract.)—This paper is the third of a series [see Abstracts Nos. 1652 (1901) and 1697 (1902)], and many of the results now published in detail have already appeared in a preliminary notice in the Proceedings [see Abstract No. 969 (1904)], but values for air, carbon dioxide, and nitrous oxide are now given. A full-page sketch of the special manometers and other apparatus is included, the general scheme being the same as in 1902, except that the two gas reservoirs, instead of being superposed, are placed side by side, thereby improving temperature conditions and eliminating the dependence on preliminary gauging. The atomic weight of carbon derived from the results for O, CO, and CO_2 are 12·003, 12·014, and 11·992. Observations were made also with ammonia, the glass surfaces being kept in contact with the gas for weeks; the mean of the results for B at temperature 9·7° was 1·00632. G. E. A.

1175. *Quartz Fibres.* **F. Horton.** (Roy. Soc., Phil. Trans. 204. pp. 407–431, May 10, 1905. Roy. Soc., Proc. 74. pp. 401–402, Feb. 24, 1905. Abstract.)—The modulus of torsion is determined by the method referred to in Abstract No. 1897 (1904). Over a range of temperature 20° to 1,000° the variation is studied. The mean value of the modulus of rigidity at 15° was found to be $8{\cdot}001 \times 10^{11}$ dynes per sq. cm. J. W. P.

1176. *Yield-point of Steel.* **C. Bach.** (Zeitschr, Vereines Deutsch. Ing. 49. pp. 615–618, April 15, 1905.)—Two values for the yielding tension may be taken, as has been shown previously [see Abstract No. 1790B (1904)]. The paper describes tests of bars cut from annealed boiler-plates of various qualities and thickness, test-pieces of different sections—round, rectangular, and H section—being used. The author finds that with round test-pieces the values of both the higher and lower "yield stress," as well as the ultimate tensile strength, are greater than with rectangular or H bars; the difference between the two values of "yield stress" is considerably greater in round bars, and almost disappear in H bars. The author ascribes this entirely to the effect of the shape of the test-pieces, and draws the conclusion that in comparing test results, particularly where value is attached to the stress which produces initial yielding, the shape of the test-piece must be considered. The paper is illustrated with curves and photographs of test-pieces illustrating the experiments recorded. W. Ros.

1177. *Methods for Studying the Viscosity of Solids.* **B. Weinberg.** (Phys. Soc., Proc. 19. pp. 472–474, April, 1905.)—Three methods are employed. (I.) The substance is in the form of a parallelopipedon, one face of which is fixed; the stress is applied to the opposite face, and the variation with time of the angle of shear is observed. This is the only method which can be employed in the case of crystalline substances. (II.) A rod or tube is subjected to twist, and the rate of rotation of different sections is observed. The method is only applicable in the case of thin tubes, the angular velocity of shearing being different for different coaxial layers. (III.) The space between two coaxial glass tubes is filled with the substance, the stress being applied by means of the tubes. Most of the experiments were performed with lead. [See also Abstract No. 1243 (1904).] S. G. S.

1178. *Pressure on Moving Surfaces in Air.* **G. Finzi** and **N. Soldati.** (Engineering, 79. pp. 333–335, March 17; 397–398, March 31; and pp. 461–464, April 14, 1905.)—The variation of pressure at points of the surfaces of variously shaped moving bodies is studied experimentally by the manometric method. The surface to be studied is fixed to a long revolving arm, and pressure tubes are led to the surface and connected to a sensitive Kretz manometer. The pressure is thus found for various positions on the surface, for various speeds, for various forms of surface—square, rectangle, circle, sphere, ellipsoid. Illustrative curves, numerical results, and mathematical treatment are given. J. W. P.

1179. *Deformation of an Elastic Plate when Heated.* **T. Boggio.** (Accad. Sci. Torino, Atti, 40. 4. pp. 197–218, 1904–1905.)—This paper begins with an historical account of the theory as developed by F. Neumann, Borchardt, and the present writer. A plate of any shape is first considered. Its middle plane section is denoted by σ, and is taken for the plane of x, y, and its contour by s. It is supposed to be unequally heated, the degree of heat being a function of the position x, y, on the middle section. The writer states the general characteristic equations (1) for points within the area σ, (2) for points on the contour s. It is impossible, owing to the very frequent changes in notation and constant introduction of new functions, to give any idea of the writer's reasoning without transcribing his work *in extenso*. After combining the fundamental equations (1) and (2), the determination of the displacements *u*, *v*, parallel respectively to *x* and *y*, of a point in the plate are shown to depend on a single biharmonic function U, which itself is determined by means of Green's first and second functions. The special case of a circular plate is also treated. S. H. B.

1180. *Deep-water Ship Waves.* **Kelvin.** (Roy. Soc. Edinburgh, Proc. 25. pp. 562–587, 1904–1905. Phil. Mag. 9. pp. 733–757, June, 1905.)—This continues the work dealt with in Abstracts Nos. 1883 and 3162 (1904). Two dimensional waves in an infinitely deep canal are produced by a moving generator, taken for the purposes of analysis to be a given continuous distribution of pressure at the surface, travelling over the surface at a given speed. The discussion by periodic functions is mainly analytical. J. W. P.

1181. *Measuring the Duration of Rainfall.* (Monthly Weather Rev. 33. pp. 17–18, Jan., 1905. From paper by **T. Okada** in Journ. of the Meteorological Soc. of Japan, p. 9, Nov., 1904.)—Okada has applied W. Köppen's method for determining the absolute duration of precipitation from observations at regular intervals, to Japanese records from 1899–1903, and compared the results deduced from hourly observations, with the records of a sensitive pluviograph of the Rung type. The comparison shows differences of 6 per cent. (12 per cent. maximum) in the total annual duration, and of 11 (25) per cent. for monthly values. Tables are given for a further comparison concerning observations made every hour, six or three times daily at eight stations in Japan in 1892 to 1901. Okada concludes that the duration of precipitations may be computed from tri-daily observations more accurately than from the gauge records. It is pointed out that the self-registering rain gauges of the U.S. Weather Bureau do not give the true time of beginning and ending of precipitation, but—what is considered more important—the duration between the first and last recorded hundredths of an inch. H. B.

1182. *Meteorology of the Equator. Observations at Pará in the Museum Goeldi.* **J. Hann.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 3–63, Jan., 1905.)—The author has examined further records sent by E. Goeldi [see Abstract No. 878 (1903)]. The nine years' barometer records are compared with data from sixteen stations situated in the equatorial belt—eight in both hemispheres. The annual variation in the amplitude of the semi-diurnal oscillation is remarkably constant; there is a maximum in January and minimum in July for both hemispheres, *i.e.*, the maximum falls in the season when the earth is nearest the sun. On the tropical seas the annual curve for the diurnal variations seems to follow the semi-diurnal oscillations. The similar harmonic analysis of the temperature records of Pará is based on three years' dates. The other observations are less complete and reliable. Humidity is determined only by a Richard hygrograph; the atmosphere is in general almost saturated with moisture, except in the noon-hours June to October. There is no double (equinoctial) rainy season; January to April are very wet, September to November the driest months (20 mm. against 50 mm. of rain daily). Thunderstorms occurred on 160 days. During the first rainy months of the year the mornings and evenings are often calm, not in the dry months. H. B

1183. *Annual Variation of the Height of Sea-level and of the Barometer in Japan.* **F. Omori.** (Mathematical and Physical Soc., Tokyo, 2. 20. pp. 297–

301, 1905.)—The author has extended his examinations [see Abstract No. 10 (1905)] to four other stations—Hamada, Wajima, Iwasaki, Otaru. The annual amounts of fluctuation of the mean monthly heights of sea-level were respectively 396, 330, 310, 278 mm., decreasing from the south to the north. This fluctuation is opposite to and 2·6 times larger than the corresponding barometric fluctuation. The sea-level was lowest in February, highest in September or October. In other words, the sea bottom is subjected to a total greater pressure in the summer months than in February to April, the difference between the maximum and minimum total pressure being equal to 1·6 times that of the annual amount of the mean barometric height. H. B.

1184. *Secondary Undulations of Oceanic Tides.* **K. Honda.** (Mathematical and Physical Soc., Tokyo, 2. 20. pp. 307–311, 1905.)—The author has continued his observations [see Abstract No. 330 (1905)] during December and January last, on the coasts of Kiushu, at eleven stations situated in six bays. The localities are the bays of Hososhima, Aburatsu, Kagoshima, Nagasaki, Hiroshima, and the straits of Shimonoseki. The sea was generally calm. The period of oscillation slightly decreases as the tide passes from low water to high water. At Hososhima the undulations seemed to be in the same phase as the tides, which indicates an oceanic, rather than a meteorological cause (N. Denison). H. B.

1185. *Solar Origin of Terrestrial Magnetic Disturbances.* **E. W. Maunder.** (Astrophys. Journ. 21. pp. 101–115, March, 1905.)—In previous papers the author has given series of comparisons indicating some intimate connection between large sun-spots and great magnetic storms [see Abstract No. 725 (1904)]. The present communication is to set out further evidence of the "*directive*" character of the solar action. From the Greenwich magnetic results since 1882 all disturbances having an amplitude of more than 20′ in declination have been selected, and it was during the examination of these that their regular occurrence at intervals of about 27 days 8 hours was noticed, corresponding to the synodic rotation period of the sun as derived by Carrington from observations of sun-spots. This suggested keeping a record of the longitude of the centre of the sun's disc at the epochs of commencement of each of the 276 disturbances under inspection, and it was then found that there was an intimate connection between certain tracts of the solar surface and the magnetic effects. Following closely on this came the interesting indication that the various disturbances do not all give precisely the same rotation period, and although the range is not a wide one the mean angular motion indicated varies from 14° 32′ to 13° 39′—values agreeing very closely with those found by Carrington for the equator and for latitude 30°. Thus the "magnetically active" areas of the sun are confined to zones the rotation periods for which correspond to those of the zones where sun-spots most congregate. This would explain why many spots, often of large size, do not appear to be connected with terrestrial magnetic phenomena, as the zone streams would not always be pointed directly towards the earth. The mean diameter appears to be about 20°. The author considers these views are in agreement with the phenomena seen during total solar eclipses, the coronal streamers extending from the sun's limb being evidence of directive streams of action. A few objections to his views are discussed and possible explanations suggested. C. P. B.

REFERENCES.

1186. *Automatic Circle-dividing Engine.* **E. Hammer.** (Zeitschr. Instrumentenk. 25. pp. 69–73, March, 1905.)—A description, with illustrations, of an automatic circle-dividing engine made by Heyde, of Dresden. The screw which gives motion to the toothed circle is described as a hollow globoid or peripheral screw, and this kind is said to fit into the teeth much more exactly than the tangential screw. G. E. A.

1187. *Harmonic Analyser.* **G. H. Rowe.** (Elect. World and Engineer, 45. pp. 587–589, March 25, 1905.)—Illustrated description of the Rowe analyser with examples of the calculations which can be effected by its aid.

1188. *Portable Aëro-mercurial Tide-gauge.* **K. Honda.** (Mathematical and Physical Soc., Tokyo, 2. 20. pp. 302–306, 1905.)—The tide-gauge used for the observations mentioned in Abstract No. 1184 (1905) is a modification of a Richard hydrometer, and consists of a diving tube, lead tubing, and a recording apparatus. The gauge is briefly described, and its theory explained. H. B.

1189. *Flow of Elastic Fluids and the Divergent Nozzle.* **M. Blieden.** (Engineer, 99. pp. 155–156, Feb. 17, and pp. 181–182, Feb. 24, 1905.)—A mathematical investigation of the speed gained by a fluid that is allowed to escape from a place of higher to one of lower pressure. This is followed by a discussion of how the quantity of fluid discharged in unit time and the sectional area of a current of fluid vary with varying falls of pressure. The theory is applied to the case of a steam turbine of the de Laval type. W. W. H. G.

1190. *Coulomb's Law.* **L. Lecornu.** (Comptes Rendus, 140. pp. 847–848, March 27, 1905.)—Further considerations on the author's attempt to reconcile the laws of sliding friction with the ordinary dynamical equations, taking account of elasticity [see Abstract No. 952 (1905)]. J. W. P

1191. *Absorption and Diffusion of Hydrogen through Palladium.* **A. Winkelmann.** (Ann. d. Physik, 16. 4. pp. 773–783, April 11, 1905.)—A criticism of Schmidt's paper [see Abstract No. 1589 (1904)] on the influence of temperature and pressure upon the absorption and diffusion phenomena for hydrogen and palladium. J. W. P

1192. *Thickness and Tension of the Capillary Layer.* **G. Bakker.** (Zeitschr. Phys. Chem. 51. pp. 344–367, March 17, 1905.)—The contents of this paper are chiefly of a mathematical character, and do not readily admit of abstraction. The author concludes from the measurements of Reinold and Rücker that the thickness of the capillary layer for soap solutions at ordinary temperatures lies between 5 $\mu\mu$ and 25 $\mu\mu$. For ether at 125° C. the calculated value for the thickness is 10 $\mu\mu$. F. G. D

LIGHT.

1193. *Effect of Surface Layer on Total Reflection.* **R. A. Houstoun.** (Phys. Zeitschr. 6. pp. 208–216, April 1, 1905.)—An account of experiments in continuation [see Abstract No. 1318 (1904)]. The effect of thin layers of collodion and silver iodide is measured, the formulæ for the case of a layer of any thickness being deduced from first principles. In the course of the measurement of phase differences by means of a Soleil-Babinet compensator, Voigt's result—that a ray of light is propagated through quartz as two elliptically polarised vibrations—is verified. G. E. A.

1194. *Luminous Efficiency of the Carbon Filament.* **C. E. Mendenhall.** (Phys. Rev. 20. pp. 160–162, March, 1905.)—The efficiency is measured for a straight carbon filament, from a 100-c.p. "Mogul" lamp, enclosed in a brass case with a fluorite window, the method employed being a slight modification of Ångström's method [see Abstracts Nos. 1511 (1902) and 2520 (1904)]. The corrected efficiency obtained varied between 2·38 per cent. for 61 watts, and 2·93 per cent. for 81·5 watts. This corresponds to a "black body temperature" of about 2,150° abs., somewhat higher than its actual temperature on account of the selective emission of the filament. G. E. A.

1195. *Accurate Measurement in Röntgen-ray Work.* **W. D. Butcher.** (Röntgen Soc., Journ. 1. pp. 74–77; Discussion, pp. 77–87, April, 1905.)—Mainly a consideration of practical points in connection with the various radiochromometers and arbitrary scales of exposure. The author suggests that a unit be determined by the Society. In the *discussion*, reference was made to the use of selenium as a photometer for the purpose [see Abstract No. 808 (1905)], and various other possible methods were suggested. L. H. W.

1196. *Optics of the Spectroscope.* **A. Schuster.** (Astrophys. Journ. 21. pp. 197–210, April, 1905.)—Wadsworth has criticised the relation between the purity and resolving power of a spectroscope with finite width of slit. The author, however, now points out a serious mistake in Wadsworth's work due to an arbitrary interpolation in one of his calculations; Wadsworth also has included the case that each spectrum line has a definite width. The power of a spectroscope depends upon its integral parts and nothing else. Certain of Wadsworth's criticisms were, however, justified, and the author puts forward the following proposals. In the image of a very narrow slit the intensity at a distance ϵ from the centre is zero; that at a distance $\epsilon/2$ is 0·40528 that of the centre. The sensible image, therefore, spreads a distance δ to either side of its centre, such that the intensity at a distance $\delta/2$ is 0·40528 that at the centre. Two lines at a distance 2δ from each other may then be said to be completely resolved, as their wave-lengths do not sensibly trespass upon each other. Observation shows, however, that visual resolution already begins when their distance is δ. This distance is adopted as the criterion of visual resolution. If a point of the spectrum defined by λ is encroached upon by waves on either side as far as $\lambda \pm \delta\lambda$, then $P = \lambda/\delta\lambda$, where P is the purity of the spectrum. Two lines will be completely separated when they are at a distance $\delta\lambda$ which $= 2\lambda/P$, and visual resolution begins when their difference of wave-length is λ/P. For very narrow slits the equations are the same, but the resolving power replaces the purity. Writing $P = pR$, p may be called the purity factor, the values of which depend upon the slit width. A table is given of the relative intensities of the successive diffraction bands round the central image, which shows that 90 per cent. of the light goes to form the central band, 2 per cent. to the bands of higher order than the fifth, and 1 per cent. to those of higher order than the eleventh. A table is given of the distribution of intensity in images of slits of finite width; from this the factor of purity was found by determining, in the first instance, the distance at which the intensity is equal to 0·40528. By doubling this distance the distance of resolution is obtained. A few of the values given are reproduced in the following table, in which col. I. gives the width of slit in terms of half the width of the central diffraction image where the slit is indefinitely narrow. In col. II. the slit widths are referred to a "normal width," defined as being such that there is an extreme difference of path of $\lambda/4$ from one of the edges of the slit to the nearest and farthest points of the collimating lens:—

I. Width of Slit.	II. Slit Factor.	III. Distance of Resolution.	IV. Purity Factor.	RELATIVE INTENSITIES.	
				V. Intensity 1 for Normal Width.	VI. Intensity 1 for Infinite Width.
0	0	1·0	1·0	0	0
0·1	0·4	1·002	0·998	0·406	0·100
0·2	0·8	1·009	0·991	0·805	0·198
0·4	1·6	1·038	0·964	1·558	0·383
0·8	3·2	1·168	0·856	2·751	0·676
1·2	4·8	1·438	0·695	3·415	0·839
1·6	6·4	1·823	0·549	3·646	0·896
2·0	8·0	2·221	0·450	3·674	0·903
3·0	12·0	3·214	0·311	3·789	0·931
D very large		D + 0·096		4·0689	1·000

The width of slit in cm. is obtained by multiplying col. I. by λ/ψ, where ψ is the angle subtended by the diam. of the collimator lens at the slit.

It can be seen from the table that, generally speaking, spectroscopes for observations in which light is a consideration should be constructed so as to give twice the resolving power actually aimed at. The slit may then be set so that its factor is 7·2. This investigation supposes that the slit behaves like a self-luminous source. When the slit is narrow the condensing lens must subtend a longer angle at the slit than the collimator; with the normal width of slit the ratio of the angular apertures should be as 4 : 1. Diffraction reduces considerably the intensity given in the table for slits having a factor < 8. Spectroscopes should therefore be designed to have about 2½ times the required resolving power and a slit with a factor of 8. E. C. C. B.

1197. *Interference with the Bi-prism.* **W. McClellan.** (Amer. Journ. Sci. 19. pp. 294–296, April, 1905.)—The coloured centre sometimes obtained with the bi-prism is due to diffraction, and pure interference effects are only obtained if $1/a + 1/b < (\mu - 1)^2 e^2/2n\lambda$, where a is distance from light to prism, b that from prism to screen, e is the acute angle of the prism, and n, a constant for all prisms, has the value 6. G. E. A.

1198. *Normal and Abnormal Dispersion in Insulating Media of Variable Density.* **M. Planck.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 18. pp. 382–394, April 6, 1905.)—In continuation of his previous paper [see Abstract No. 1909 (1904)] the author here discusses at further length the electromagnetic theory of dispersion and the extinctions coefficient of a selectively absorbing medium. The following expressions are given for the index of refraction (ν), and the extinctions coefficient (κ), for plane periodic waves :—

$$\left.\begin{aligned}\nu^2 &= \left\{\sqrt{(\alpha^2+\beta^2-\alpha)^2+\beta^2}+(\alpha^2+\beta^2-\alpha)\right\}/2(\sigma^2+\beta^2)\\ \kappa^2 &= \left\{\sqrt{(\alpha^2+\beta^2-\alpha)^2+\beta^2}-(\alpha^2+\beta^2-\alpha)\right\}/2(\alpha^2+\beta^2)\end{aligned}\right\}\ldots\ldots(1)$$

where—

$$\alpha = \left\{\lambda_0^2-(1-g)\lambda^2\right\}/3g\lambda^2, \qquad \beta = \sigma\lambda_0^3/3\pi g\lambda^3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2).$$

Here λ is the wave-length in vacuum, λ_0 that of the vibrations natural to the insulated molecules, σ the logarithmic decrement of these molecular vibrations, and $g=\sigma N\lambda_0^3/4\pi^3$......(3), in which N is the number of molecules per unit volume. Three types of dispersion curves are then discussed.

E. H. B.

1199. *Microscopic Determination of Position of a Mirror.* **K. Prytz.** (Ann. d. Physik, 16. 4. pp. 735–745, April 11, 1905.)—Describes with diagrams a sensitive microscopic method of locating the exact position of a reflecting surface. In order to illuminate the little mirror in question a side tube is fitted to the body of the compound microscope, and in this is thrust a conical piece of clear glass with its small end turned through a quadrant towards the objective. Light sent through this conical glass rod from the outside suffers total internal reflection, and is thus directed as desired. Tables of observations are given showing the accuracy obtainable by the method, which is said to have numerous applications. E. H. B.

1200. *Electromagnetic Theory and the Velocity of Light.* **H. T. Eddy.** (Phys. Rev. 20. pp. 193–219, April, 1905. Presented in Abstract at the St. Louis International Congress of Arts and Sciences, Sept., 1904.)—The conclusions arrived at may be stated as follows: (1) The change of speed of circularly polarised light, observed by Mills and by Brace, is perfectly in accord with and a necessary consequence of the elementary trigonometrical equations expressing the propagation of twisted plane-polarised light, and the phenomenon is independent of any hypothesis, electromagnetic or otherwise, as to the manner in which the twisting is produced. (2) Rowland's equations to express the propagation of twisted plane-polarised light are not suitable for the purpose, for they, in fact, express the propagation of a uniformly and continuously rotated plane-polarised ray, such as is at present unknown to experimental physics. (3) The speed of a twisted plane-polarised ray is the *harmonic* mean of those of the right and left circularly polarised rays of which it is composed, whereas the speed of Rowland's rotating plane ray is the *arithmetic* mean of the speeds of its components. (4) MacCullagh's differential equations involve practically the same decrease of speed by the medium as those based on orbital motions of charged ions. E. H. B.

1201. *Dispersion of Light due to Electron Atoms.* **H. Nagaoka.** (Mathematical and Physical Soc., Tokyo, 2. 18. pp. 280–285, 1904.)—The dispersion of light, viewed from the standpoint of the elastic theory, presents several difficulties, which for the most part arise from the different conceptions as to the constitution of the medium through which the light is transmitted.

When the molecules causing the dispersion are only those composed of electron atoms, many of the hypotheses which otherwise enter into the discussion disappear. The present paper deals with this problem mathematically along the lines indicated, and derives a result equivalent to the Ketteler-Helmholtz formula. An additional advantage lies in the fact that every term of the formula can be physically interpreted without introducing additional hypotheses, which in the elastic theory are needed for the interpretation of dispersion, but for that alone. E. H. B.

1202. *Circular Dichroism in Natural Rotatory Solutions.* **M. F. McDowell.** (Phys. Rev. 20. pp. 163–171, March, 1905.)—Employing Brace's half-shade elliptical polariser and compensator [see Abstract No. 1013 (1904)], the author has examined, in all parts of the spectrum, various solutions of double salts giving anomalous rotations, and has established the form of the curves within the absorption band of all the solutions studied where this was within the visible spectrum. Contrary to Cotton's results, circular dichroism is found in all cases where there is marked anomalous rotation, all that appears necessary being a double salt formed by the combination of an optically active acid, or its salt, and the salt of some other acid. W. H. SI.

1203. *Spectrophotometric Study of Solutions of Copper and Cobalt.* **B. E. Moore.** (Phys. Rev. 19. pp. 456–457, Dec., 1904. Abstract of paper read before the Amer. Physical Soc., Sept. 16, 1904.)—The absorption of solutions of certain salts of copper and cobalt were spectrophotometrically determined, comparison being made between strong solutions and those diluted with water and the corresponding acid respectively. It was found that copper sulphate gives the same result whether diluted with sulphuric acid or water, *i.e.*, the colour of the ion and molecule are the same. Certain differences were observed in the case of the other salts. E. C. C. B.

1204. *Spectrum of Tungsten in the Electric Arc.* **B. Hasselberg.** (K. Svenska Vet. Akad., Handl. 38. No. 5. pp. 1–47, 1904.)—On the whole, the same lines are found in the arc spectrum of tungsten as occur in the spark spectrum obtained by Exner and Haschek, but there is very marked variation in the relative intensities of the lines in the two cases. The lines regarded by the author as characteristic of tungsten are given, together with reproductions of the spectra. Various lines in the spectrum of tungsten coincide with faint lines in the solar spectrum, from which it is concluded that tungsten is present in the absorbing envelope of the sun. T. H. P.

1205. *Negative Band Spectrum of Nitrogen under Strong Dispersion; its Variations with Pressure.* **H. Deslandres.** (Comptes Rendus, 139. pp. 1174–1180, Dec. 26, 1904.)—This spectrum is that of the negative glow in a vacuum tube filled with air or nitrogen, and under a medium dispersion has a simple structure, each band being formed by a series of alternate strong and weak lines. The oscillation frequencies of the rays can be represented by the general formula, $N = f(n^2p^2) \times m^2 + Bn^2 + \phi(p^2)$, in which m, n, p, are three series of successive whole members and B is a constant; f and ϕ represent some function of these variables. The variations of m, n and p being constant, give the lines of one band; if n varies at the same time, p being constant, this gives a single series of bands. The variations of p give the series of bands. In this particular case p has 5 values, n 7, and m at least 30.

A detailed description of the spectrum is given. Hemsalech has stated that this spectrum is given by the electric spark in air between poles of certain metals, if capacity and self-induction are introduced. The author has, however, compared the two spectra under strong dispersion, and finds considerable differences in the structure of the bands, and, moreover, shows that this difference is entirely due to the difference of pressure. The reason for these differences in the spectrum are very difficult to explain. E. C. C. B.

1206. *Variation in the Band Spectra of Carbon with Pressure; New Band Spectra of Carbon.* **H. Deslandres** and **d'Azambuja.** (Comptes Rendus, 140. pp. 917–920, April 3, 1905.)—In a previous paper [see preceding Abstract] the variations in the negative band spectrum of nitrogen were dealt with, and it was shown how new series of lines were developed when the pressure of the gas was increased. In the present paper an investigation into the negative band spectrum of carbon is described. This spectrum consists of seven bands in the ultra-violet, each one of which only contains a single series of lines in arithmetical progression. They are very like the negative nitrogen spectrum in that they possess a dark space caused by the failing of several consecutive rays in the series. The study of the variations in this spectrum was made by photographically comparing the spectrum of a vacuum tube with the spectrum of the bright point of light on the kathode of the spark at varying pressures. The changes observed are exactly similar to those observed in the case of the negative nitrogen spectrum, the dark spaces being filled with the rays of a new series as the pressure increases. The authors believe that these changes will prove to be general. Two new band spectra of carbon were observed; one, a set of bands between $\lambda = 4680$ and $\lambda = 3300$, in the spark at atmospheric pressure through the oxides of carbon with capacity and self-induction. The second spectrum was observed in the bright point of the kathode with sparks in carbon dioxide at ordinary pressure. They are degraded towards the red, and their intensity varies with the pressure (maximum at 300 mm.). Both these new spectra were obtained with electrodes of Al, Ag, and Cu. E. C. C. B.

1207. *Determination of Wave-lengths in the Extreme Ultra-violet Portion of the Spectrum.* **H. Morris-Airey.** (Manchester Lit. and Phil. Soc., Mem. 49. 3. pp. 1–9, Jan. 16, 1905.)—A vacuum spectrograph was employed with a transmission grating ruled on a fluor-spar plate with 500 lines per mm. The best results were obtained with aluminium electrodes and the discharge from a coil, capable of giving a spark of 1 m. in air, condensed to about 1·5 cm. spark-length. The discharge was made to pass over the surface of the fluor-spar window of the slit so as to reduce the absorbing air layer to a minimum. The wave-lengths were determined by the method of rotating the grating through a measurable angle, using as fiducial mark a fine steel point fixed in the camera, whose shadow appeared on every photograph. The wave-lengths determined were $\lambda\lambda = 1785$, 1741, 1709, and 1693. E. C. C. B.

1208. *Spectrum of Magnesium.* **J. Barnes.** (Astrophys. Journ. 21. pp. 74–80, Jan., 1905. Phys. Zeitschr. 6. pp. 148–151, March 1, 1905.)—An investigation into the variation of the relative intensity of the spark and arc lines in the arc discharge between magnesium poles with change of pressure and of current strength. It was found that when the strength of the current is diminished the arc lines are weakened, but that the spark lines, as evidenced by the line at $\lambda = 4481$, are strengthened in intensity. When the arc was surrounded with an atmosphere of hydrogen this effect was more marked. When the arc was made in a vacuum the line at $\lambda = 4481$ was well marked, and was not changed by any change in current strength. The same facts were observed in the case of zinc. These results can be explained by Crew's proposition [see Abstract No. 68 (1905)], that a rapidly changing high e.m.f. is the essential condition for spark lines. [See also Abstract No. 1359 (1903).]

E. C. C. B.

1209. *Spectra of Weak Luminescences.* I. *Fluorescence Spectrum of Fluor-spar.* **H. W. Morse.** (Astrophys. Journ. 21. pp. 83–100, March, 1905.)—The author has found that the so-called orange band in the fluorescent spectrum of fluor-spar can be resolved into a number of more or less well-defined lines or bands. These, however, vary to a certain extent, and the results of a preliminary investigation are given. A series of purple fluorites from Weardale were experimented upon. The fluorescent lines disappeared when a glass plate was interposed between the exciting cause and the crystal, showing that the excitement was due to ultra-violet light. Different sources (sparks between different metals) also excited different rays in the fluorescent spectrum of the same crystal, and different crystals give different lines with the same exciting source. The spectra were photographed with a spectroscope of small dispersion, and tables are given showing the wave-lengths of the lines obtained with two crystals with sparks between different metals as the source. The author concludes that the entire fluorescence spectrum contains a great number of lines or maxima, a part of which are excited by the light from one spark, another part by another spark, &c., and that it must in fact be considered the sum of all the lines that are excited by all the different sparks. The want of accuracy in the measurement of the wave-lengths prevents a definite statement as to whether certain maxima are really common to the fluorescence spectra excited by different sparks. Certain of these maxima are evidently peculiar to the light excited by a single metal, as no small error in the wave-lengths could account for the different distribution of the strong lines in the various spectra produced in the same crystal by different exciting causes. The strong lines in the fluorescence spectra lie between $\lambda = 5700$ and $\lambda = 6400$. The whole spectrum excited by a metal like iron extends from $\lambda = 4000$ to $\lambda = 7000$, the part from $\lambda = 4000$ to $\lambda = 4800$ by the broad blue band which is excited by light of not much shorter wave-length. The part from $\lambda = 4800$ to $\lambda = 5700$ contains many narrow bands and some rather weak, sharp lines, and the part from $\lambda = 5700$ to $\lambda = 7000$ contains the strong sharp lines. All attempts to explain the mechanism of these phenomena as yet have failed. None of the lines appear to belong to the spectrum of any known substance. The strongest line falls upon Crookes' "Citron band," but there were found no other even approximate coincidences with the spectrum of yttrium. The possibility of optical resonance has been examined, but with negative results. The source of the fluorescence is completely removed by heating the crystals to above 300°; a crystal so treated may again be made to give the blue band of fluorescence ($\lambda = 4800$–$\lambda = 4000$), but the red fluorescence, which gives the bright lines, is not regenerated.

E. C. C. B.

1210. *Two Line-spectra of Mercury.* **J. Stark.** (Ann. d. Physik, 16. 3. pp. 490–515, March 14, 1905.)—The spectrograph used for this investigation was a three-prism instrument made of the new glass which is transparent to ultra-violet light. The mercury vapour was illuminated either by a current of 2–3 amps. from a 135-volt accumulator battery (arc discharge) or by a current of 0·001–0·08 amp. from a 3,000-volt battery (glow discharge). The author distinguishes between two line-spectra of mercury, one which is given by the arc discharge and the other which contains those lines which are present in the spectrum of the glow discharge, over and above the lines of the first spectrum and the band spectra. The spectra were measured between the limits of $\lambda = 6152$ and $\lambda = 3341$; the values of Kayser and Runge's and of Eder and Valenta's measurements were adopted, the wave-lengths of new lines being found by interpolation. The author points out that the number and wave-lengths of the lines in the first spectrum are quite independent of the mean temperature of the discharge, but that certain changes in the relative intensities are introduced by altering the temperature of the discharge, *i.e.*, by altering the diam. of the vacuum tube and keeping the current constant. The second line-spectrum is apparently introduced when the potential gradient along the line of discharge is very much steeper. The author concludes that the first spectrum is due to the monovalent mercury ion, and the second spectrum to the divalent ion. According to this view an element should give as many line spectra as it has different valencies. Band spectra are produced by the union of the electron with an ion to form the neutral atom. There should thus be two distinct band spectra of mercury, one due to the change from the di- to the mono-valent ion, and the other due to the change from the monovalent ion to the neutral atom [see Abstract No. 2883 (1904)]. [It is noteworthy that the spectrum of the glow discharge is very like that of the jar and spark discharge as observed by Eder and Valenta. It seems, therefore, more likely that the two mercury spectra stand in the same relation to one another as the arc and spark spectra of any other element—that is to say, independent of the possible existence of the element in different conditions of valency.] E. C. C. B.

1211. *Spectroscopic Observations of Light of Periodically Variable Intensity.* **O. M. Corbino.** (Accad. Lincei, Atti, 14. pp. 332–339, March 19, 1905.)—An originally sinusoidal vibration whose amplitude is caused to vary periodically, may be represented by $s = \phi(t) \sin \omega t$, where ϕ is a periodic function. Expanding $\phi(t)$ in a Fourier's series we have $\phi(t) = \Sigma_m a_m \cos(m\omega' t + \alpha_m)$, and the relation is represented by $s = \Sigma_m a_m \cos(m\omega' t + \alpha_m) \sin \omega t$, whose general term is $a_m \left\{ \sin[(\omega + m\omega')t + \alpha_m] + \sin[(m - m\omega' t) - \alpha_m] \right\}$. This evidently represents two vibrations, of frequencies $(\omega + m\omega')/2\pi$ and $(\omega - m\omega')/2\pi$, and hence for each bright line in the original spectrum, every term in the Fourier's series gives rise to two lines in its place, situated at equal distances on either side of the original position. Taking into account all the terms of the series, we should have a number of equally spaced lines in place of the original line. Since we cannot, with the ordinary spectroscope, obtain sufficiently high resolving power to observe these lines, the author proceeds to treat the problem in another way; the original equation is written in the form $s = \phi(t) \sin \omega t = \sin\left\{\omega t + \cos^{-1}\phi(t)\right\} + \sin\left\{\omega t - \cos^{-1}\phi(t)\right\}$. This is equivalent to two vibrations, and it is shown that they are related to the original by the equation $T_1 = T\left\{1 \pm \frac{1}{\omega} \frac{\phi'(t)}{\sqrt{1 - \phi^2(t)}}\right\}$, where T and ω refer to the original vibration. This is shown to be equivalent to a doublet of which the components oscillate rapidly. The author suggests the application of the method of Abraham and Lemoine [see Abstract No. 857 (1900)] and of James [Abstract No. 797 (1905)] for producing a beam whose alternations in intensity are sufficiently rapid to show the lines above described. The voltage, frequency of discharge, and size of condenser are calculated for the lines studied to be separated by about 1/1000 the distance between the two sodium lines. With the direct light from an oscillating spark occurring in vaseline, the lines should be separated by a distance equal to 1/15 that between the D lines. The experiments to be undertaken are to form a separate communication. S. G. S.

1212. *Emission Spectrum of the High-tension Arc.* **J. de Kowalski** and **P. Joye.** (Comptes Rendus, 140. pp. 1102–1103, April 17, 1905.)—In the neighbourhood of the kathode in the case of cadmium and zinc arcs certain bright lines have been observed in the spectrum, the wave-lengths of which agree with those observed by Watteville in the flame spectra of these metals. Apparently, therefore, there exists a sheath of luminous metallic vapour around the kathode, which is in an analogous condition to that of the inner cone of a Bunsen flame. E. C. C. B.

1213. *Radiation Effects on Photographic Plates.* **W. Merckens.** (Ann. d. Physik, 16. 4. pp. 667–683, April 11, 1905.)—The phenomena connected with the radiation effects produced by organic and inorganic bodies on the silver-bromide-gelatine plates used in photography, have given rise to an extensive literature, and the views put forth as to the nature of the phenomena are very divergent. The object of the author's researches was to determine whether actual radiation occurred (*i.e.*, an action due to ethereal vibrations) or if the effects produced were of a purely chemical nature. A summary is given of previous researches. The first important conclusion reached was the explanation given by W. J. Russell [see Abstract No. 908 (1898)], who considered the action to be due directly or indirectly to hydrogen peroxide. The results of the author's observations confirm Russell's views. The action of vibrations of the ether appears to be excluded, and the darkening of the photographic plates is due to the presence of hydrogen peroxide vapour or the presence of nascent oxygen, by which latter the bromide of silver appears to be oxidised to an easily-reduced silver salt. Experiment supports this explanation. The action of ozone is similar to that of hydrogen peroxide, probably owing to the presence of nascent oxygen from decomposing ozone. Further researches to determine whether the electric current acts on bromide of silver gelatine gave no trustworthy result: the effects observed were generally connected with the presence of vapour of hydrogen peroxide. [See also Abstracts Nos. 532, 836, and 1008 (1905.)] J. J. S.

1214. *Variations of Brightness produced by a Crookes Tube.* **S. Turchini.** (Comptes Rendus, 140. pp. 1139–1141, April 25, 1905.)—The author has investigated the variations in brightness of a barium-platinocyanide screen, excited by a Crookes tube, as a function of (1) the equivalent spark; (2) the current in the secondary; (3) the frequency of the interrupter; and (4) the coil used. The tube was placed a fixed distance from the screen, and the brightness of the latter compared with that of a plate illuminated by an incandescent electric lamp provided with coloured screens. As regards (1), the brightness with constant current strength increases with the equivalent spark up to 10–12 cm. and then remains constant. With constant equivalent spark [see Abstract No. 800 (1905)] the brightness increases with the current. (With a higher frequency and larger current a maximum is passed through.) (2 With the same current the brightness diminishes as the frequency increases. (3) The smaller coil (25 cm. spark) produced greater brightness than the large one (45 cm. spark) with the same equivalent spark. (4) The larger coil had a primary of variable inductance; the greatest brightness was obtained with the maximum amount of inductance (value not stated). L. H. W.

1215. *Radiographic Power of a Röntgen-ray Tube.* **S. Turchini.** (Comptes Rendus, 140. pp. 1325–1327, May 15, 1905.)—The author has already studied the variations of brightness produced by a Röntgen-ray tube [see preceding Abstract]. He now applies the method to radiography, sixteen exposures being made on one plate—eight each with the large and the small coil, with four different equivalent spark-lengths and two different current strengths, at 31 interruptions per sec. The images were then measured by Camichel's photometric method [see Abstract No. 539 (1904)]. The results are given in tabular form, and show that, as in the visual observations, the effect (density) increases up to 10 cm. equivalent spark; the images are stronger with the small coil. There is therefore no advantage to be gained by using a longer equivalent spark than 10 or 12 cm. L. H. W.

1216. *Action of Röntgen Rays on Platinocyanides.* **H. Bordier** and **J. Galimard.** (Archives d'Él. Médicale, 13. pp. 323–326, May 10, 1905.)—The change of colour produced in platinocyanides—especially barium platinocyanide—by Röntgen rays is shown to be due to a dehydration of the salt. Change of colour occurs in the case of other platinocyanides, as can be seen below:—

	Before dehydration.	After.
Magnesium platinocyanide.........	Vermilion	White
Ammonium ,, ...	Old gold	Yellowish-pink
Potassium ,, ...	Greenish-white	Yellow ochre
Barium ,, ...	Green	Gold

The change of colour does not take place at the same rate in all these cases, and similarly with the regeneration—which takes place on exposure to moist air. The barium salt changes colour most quickly and regenerates most slowly: the magnesium salt regenerates itself the quickest, but is slowest in changing colour. Various practical points of value in connection with the use of the salts in radiotherapic measurements, and notably in Sabouraud and Noiré's method [see Abstract No. 2980 (1904)], are dealt with.

L. H. W.

1217. *Ionisation produced between Parallel Plates by Radium Emanations.* **W. Duane.** (Comptes Rendus, 140. pp. 786–788, March 20, 1905.)—The author has recently shown [Comptes Rendus, 140. pp. 581–583, Feb. 27, 1905] that the current produced by unit radium emanation distributed in the air is 0·63 electrostatic unit, if all the rays are absorbed by the air. In the present experiments, which verify this conclusion and also give the law of absorption by the air of the emanating rays and of the induced radio-activity, a plate condenser with guard-ring is placed under a bell-jar into which air charged with a known amount of emanation can be introduced. A p.d. of several hundreds of volts is established between the plates of the condenser and the corresponding current measured at the central part by means of piezo-electric quartz. For various distances between the plates, measurements are made of:

(1) The initial current at the moment of introduction of the emanation, represented approximately by $I = 0{\cdot}63\,[d - (1 - \epsilon^{-d})]$, the amount of emanation in each cub. cm. of air being 1, and d being the distance apart of the plates. This is in agreement with the theoretical formula $I = C\,[d - k\,(1 - \epsilon^{-ad})]$, in which C, k, and a are constants. (2) The second measurement is that of the maximum current at the end of 3 hours, giving the sum of the currents due to the emanation and to the induced radio-activity. The results obtained are well represented by the expression, $I = C_1 d\,(1 - \epsilon^{-\beta d})$, where $C_1 = 0{\cdot}63$ and $\beta = 0{\cdot}72$, although theory would indicate a formula containing two exponentials, since the active bodies contain two substances (A and C) ; β may be regarded as a coefficient of absorption intermediate to those of the radiations from A and C. (3) The current obtained 30 min. after the emanation has been removed by renewing the air. The current is here due only to the third substance C of the induced radio-activity, and is found to be represented by $i = i_0\,(1 - \epsilon^{-\gamma d})$, when the distance apart of the plates is alone varied with a given activity of their surface. These results lead to the following conclusions : Admitting that the charge of an ion is $e = 3 \times 10^{-10}$ electrostatic units, the maximum number of ions of each sign produced in a second by the unit of emanation is $0{\cdot}63/e = 2{\cdot}1 \times 10^{-9}$. If the energy required to ionise a molecule of air is equal to 3×10^{-11} ergs, the energy of ionisation produced by the unit of emanation during its existence equals $3{\cdot}13 \times 10^{4}$ ergs. If the emanation in equilibrium at the end of a prolonged time with 1 gm. of radium bromide is equal to that occupying 0·00083 cub. cm. in the gaseous state, and at 0° and 760 mm. pressure, and if the number of molecules in each cub. cm. multiplied by the charge of an ion equals $1{\cdot}24 \times 10^{10}$, it follows that every molecule of emanation, in destroying itself, produces 14,500 ions of each sign. The energy used in producing these ions is equal to $4{\cdot}4 \times 10^{-7}$ ergs, or about 1/13 of the energy of a particle α found by Rutherford. T. H. P

1218. *Calorific Action of Radium Bromide, of Naphthalene and of Camphor.* **N. A. Hesehus.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 37. No. 1. pp. 1–9, 1905.)—Former experiments (1903) led the author to the conclusion that the elevation of temperature produced in bodies placed near radium bromide is due chiefly to the absorption of the emanation itself by the thermometer or other object exposed to it ; the heating shows itself only during the absorption and reaches a limit when saturation is complete. The question arose whether odoriferous substances that throw off small particles, such as camphor and napthalene, might not exhibit similar heating phenomena. Pieces of naphthalene and camphor were placed under one of two similarly-placed thermometers (reading to hundredths of a degree) ; the temperature of this thermometer rose a definite amount, and fell again when the naphthalene or camphor was removed. The experiments were repeated with a thermopile (of which one scale division represented 0·000722°), and here again the results were quite similar to those with radium bromide, though the actual heating observed was less. Thus in certain experiments in which a thermometer was exposed to the action of 10 mgm. of radium bromide, the rise of temperature was 0·6° ; this may be compared with a rise of 0·03° due to naphthalene. The author satisfied himself that the heating was not due to n-rays. D. H. J.

1219. *Radiation from Ordinary Materials.* **N. R. Campbell.** (Phil. Mag. 9. pp. 531–544, April, 1905.)—The ionisation of the air in a closed vessel, produced by the radiation from the walls of the vessel, is determined by measuring the saturation current, or leak, by employing a Wilson gold-leaf electroscope and an arbitrary constant capacity. The air is contained in a rectangular vessel, one side of which can be moved parallel to itself, and the walls of the vessel are coated with the material the effect of whose radiation it is required to investigate. The leak between the moveable wall and a piece of gauze hanging parallel to it is measured, and in this way curves for saturation current and distance of moveable side from gauze are obtained. Pb, C, Al, Zn, Pt, and tin-foil are investigated, and it is found that above a certain distance the curves become straight; hence the total ionisation is proportional to the volume of the air, which fact indicates the presence of a highly penetrating radiation. At less distances the curve is due to this and another radiation which is completely absorbed by a few cm. of air. The curves are explained on the assumption that this highly absorbable radiation is spontaneous, and due to the wall of the vessel, while the highly penetrating radiation comes from outside, as found by Cooke [see Abstract No. 546 (1904)], and the relative amounts of these two radiations are determined. A similar set of observations is described, in which the chamber is surrounded by a lead shell 3 cm. in thickness, which should reduce by two-thirds the intensity of Cooke's radiation. In all cases the spontaneous absorbable radiation is reduced (in the case of Pt to nothing); thus the radiation is in all cases partially secondary and in the case of Pt wholly so. This result was also arrived at by Wood [see Abstract No. 2680 (1904)]. Different specimens of the same material appear to have the same radiating power. The author then describes experiments in which the coefficient of absorption of the rays for air and Al are determined, and it is found that these differ for the rays from different materials, thus indicating that the rays emitted by different substances are different in kind. Taken altogether it is unlikely that the rays are due to radio-active impurities.

S. G. S.

1220. *Radio-activity and Chemical Change.* **N. R. Campbell.** (Phil. Mag. 9. pp. 545–549, April, 1905.)—The effect of chemical reaction in producing radio-activity is investigated by placing the reagents in a dish immediately under a window in a vessel designed to measure ionisation by leakage, and in which the induction effect due to surface electrification of the insulation is avoided; the window is covered with various materials in the different experiments. In all cases in which no gas is evolved during the reaction the effect appears to be due to the heating or cooling produced by the reaction, since a similar or even greater change in the rate of leakage could be produced by artificial warming or cooling, the reagents not being present. The radioactivity therefore seems to be a secondary effect, due to the heating or cooling due to chemical change. In the cases in which gas is evolved the leakage is much increased, but the effect can be greatly reduced by blowing a current of air over the dish; also a layer of zinc 0·8 mm. thick can be interposed between the window and the dish without in any way diminishing the effect. The free ions and not the radiation must therefore be the cause of this effect. S. G. S.

1221. *Spontaneous Ionisation of Air in Closed Vessels and its Causes.* **A. Wood.** (Phil. Mag. 9. pp. 550–576, April, 1905.)—The apparatus for determining the shielding effect of lead and other materials, in reducing the spontaneous ionisation of the air in a closed vessel, and the method of making the experiments, are described in great detail. With a cast-iron box 1 cm. thick as screen, the reduction in ionisation is 8 per cent.; with a 5 cm. iron screen, 20 per cent.; with 1 cm. of lead, 12 per cent.; and 35 cm. of paper, 3 per cent. A reduction occurs with all materials except wood, in which case there was an increase of 8·5 per cent. Assuming, then, that the radiation causing ionisation is a penetrating one from outside, an attempt was made to determine the direction from which it comes by placing lead screens in various positions with respect to the apparatus; the result, however, was a negative one. Experiments with the object of determining whether the radiation from the walls of the vessel is of a primary or secondary character, showed that the percentage reduction of the ionisation produced in vessels of different materials was not the same, and hence it is concluded that part of the ionisation is due to an intrinsic radiation from the walls of the vessel. Moreover, the rates of ionisation in vessels of different materials are in agreement with those found by Strutt [see Abstract No. 1420 (1904)] and Campbell [see preceding Abstract]; the author therefore considers that all matter is radio-active; also that the ionisation in the vessel is due to a threefold cause: an intrinsic radiation, a penetrating radiation from outside, and a secondary radiation produced in the walls of the vessel by the latter. In the case of Sn, Fe, and Zn the radiation must be largely secondary, while in that of Pb and Al it must be largely intrinsic. In the search for an emanation, driven from the metal on heating, it is found that ionisation can be carried from one vessel to another; but whether the active agent is in the form of ions or a short-lived emanation which gives rise to the ions, could not be determined. An experiment is described showing that lead, when cleaned with nitric acid, exhibits an increase in radio-activity, but on being polished mechanically the activity at once falls. It is suggested that this is caused by a film, formed by polishing, which covers the interstices between the crystals of the metal and prevents the escape of the emanation, but which is removed by the acid. [See Abstract No. 92B (1904).] S. G. S.

1222. *Radio-activity as an Atomic Property.* **H. N. McCoy.** (Amer. Chem. Soc., Journ. 27. pp. 391–403, April, 1905. Contribution from the Kent Chem. Lab., Univ. of Chicago.)—The experiments here described show that the effective activity of the layers of uranium compounds sufficiently thick to show the maximum α-ray activity depends not only on the uranium content but also on the coefficient of absorption of the rays by the radio-active substance itself. The following method of determining such absorption coefficients is given. A thin layer, of weight w, of the radio-active substance is spread uniformly upon a metal plate of area s; then, if A is the observed activity, as measured electrically, it can be readily shown that—

$$dA/dw = \tfrac{1}{2}(k_1 - k_2A/s) \ldots\ldots (1),$$

where k_1 is the total activity for no absorption of the rays, and k_2 is the constant of absorption for unit mass of substance upon unit area. The factor $\frac{1}{2}$ is used, since half of the rays are directed downward and are absorbed by the metal plate. Integration of (1) gives—

$$A = (k_1s/2k_2)(1 - e^{-k_2w/s}).$$

For all but small values of w, $e^{-k_2/ws}$ is practically zero and $A = k_1s/2k_2 = A_1$ where A_1 is the maximum value of the function. Therefore $A = A_1(1 - e^{-k_2w/s})$. By means of this equation it is possible to determine k_2 and k_1 from the observed activities of layers of different weights. If $A/A_1 = x$, then $k_2 = (2{\cdot}303\ s/w) \log [1/(1 - x)]$. By sifting the powdered material on to a plate it is almost impossible to obtain perfectly uniform layers much thinner than 0·03 mm. To prepare thin layers a good way is to grind the compound in an agate mortar with a volatile liquid, in which it is insoluble, and then to pour the liquid containing the suspended substance into a shallow, flat-bottomed metal dish. After evaporation of the liquid the solid is left as an exceedingly uniform, thin film sometimes not more than 0·0005 mm. in thickness. Experiments made with such films of urano-uranic oxide (U_3O_8), uranyl oxalate ($UO_2C_2O_4$, $3H_2O$), and ammonium uranate [$(NH_4)_2U_2O_7$], show that, when absorption is taken into account, the total *α*-ray activity of any uranium compound is strictly proportional to its percentage of uranium, thus confirming the theory that radio-activity is an atomic property. T. H. P.

1223. *Properties of Radium in Small Quantities.* **A. S. Eve.** (Phil. Mag. 9. pp. 708–712, May, 1905. Phys. Zeitschr. 6. pp. 267–269, May 1, 1905. Appendix by **E. Rutherford.**)—According to Voller [see Abstract No. 2892 (1904)] the life of radium is considerably shortened if the radium salt which is tested is taken in very small amounts. Thus if the mass is 10^{-4} mgm. the life is 126 days, if 10^{-9} mgm. the life is reduced to 15 days. This is so opposed to the usual theories of radio-active change that Eve has repeated the experiments. The results entirely negative those of Voller. The activity is always proportional to the quantity of the salt present, and in one case where 10^{-6} mgm. was spread over 76 sq. cm. by deposition from solution, more than 40 days have passed since the maximum activity was reached, although, according to Voller, the activity should have disappeared entirely in about 20 days. Eve points out that as Voller's experiments were carried out with the radium exposed to the free atmosphere, the decrease in activity is due to the dispersion of the active matter into the surrounding space. In his own investigations the salt is always tested in a closed vessel. R. S. W.

1224. *Heating Effect of the γ-Rays from Radium.* **E. Rutherford** and **H. T. Barnes.** (Phil. Mag. 9. pp. 621–628, May, 1905.)—Results already attained by the authors indicate that the heating effect of radium is due mainly to the bombardment of the active matter by the *α*-rays. Paschen has come to the conclusion that 50 per cent. of the heat is due to the *γ*-rays. [See Abstract No. 351 (1905).] In his experiments the rays are absorbed by lead and the heating effect measured by means of a differential ice-calorimeter. It is sought to verify this conclusion. The differential air-thermometer, already used in previous experiments, is the measuring instrument. The radium is enclosed in lead or aluminium cylinders, and in order to avoid the uncertainty introduced by the different heat conductivities of the two metals, each set of observations is standardised by a heating coil. It is found that the heating effect of the *γ*-rays is only a very small fraction of the total heat emission of radium. R. S. W.

1225. *Phosphorescence Caused by the β- and γ-Rays of Radium.* **G. T. Beilby.** (Roy. Soc., Proc. 74. pp. 506–510, and pp. 511–518, March 16, 1905.)—Barium platinocyanide, after exposure to the rays from radium, becomes brown or red, whilst the excited phosphorescence falls off. When yellow crystals were left on the mica cover of a cell containing 30 mgm. of radium bromide the beginnings of the colour change were visible after 30 min.; in 8 hours the phosphorescence had fallen to 8/100 of its original amount, at which it remained at the end of 8 days. When the reddened crystals were removed from the action of the rays they at once ceased to phosphoresce. The phosphorescence could not be restored by exposure to sunlight, but after recrystallisation from water the crystals were the same as before exposure (no chemical change). When the water of crystallisation is expelled, the crystals, red or yellow, are converted into an amorphous brick-red powder, the phosphorescence falls to 2 per cent., and the glow is no longer green, but red. The change under the influence of the β-rays is, however, not due to the loss of water of crystallisation. Similar changes are produced by crushing the yellow salt. Heating in a sealed tube (to prevent dehydration) to 120° transformed the reddened crystals so produced sharply into the yellow salt. The phosphorescence was raised from 8 per cent. to 38 per cent. The persistence of phosphorescence even in the amorphous form of the substance seems to point to the necessity for a more general explanation of the phenomena of phosphorescence. A polished lens of rock-crystal after exposure to the rays during 4 days showed a dark brown colouration at the spot where the rays had entered. On removal from the radium the patch phosphoresced faintly; after 6 weeks there was no trace of phosphorescence, but when heated to over 100° the coloured patch glowed brightly. Heated to about 250° it glowed more brightly, and then ceased glowing. The brown colouration had then completely disappeared. Further experiments on the same lines with a crystal of calcspar are described. The explanation given is that the solid is electrolysed by the rays, the products being partly insulated from each other by the neutral molecules, as in a viscous electrolyte. Some recombination takes place at once, giving rise to primary phosphorescence, the gradual recombination after the removal of the excitation produces secondary phosphorescence. As a higher temperature is reached the insulation is progressively weakened, and at each temperature a further supply of energy is thus released, giving rise to the phenomena of revived luminescence. T. M. L.

REFERENCES.

1226. *Fleuriais' Gyroscopic Horizon.* **M. E. J. Gheury.** (Phys. Soc., Proc. 19. pp. 362–364, Dec., 1904.)—[A description of the latest form of the instrument made by Messrs. Ponthus and Therrode is given in Engineering, 79. pp. 361–362, March 17, 1905.]

1227. *Propagation of Rays in Dispersive and Absorptive Media.* **M. Laue.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 480–494, Dec., 1904.)—A mathematical discussion of the above questions following upon the work of W. Voigt and M. Planck. E. H. B.

1228. *Method for Determining the Principal Directions and Optical Constants in the Case of Double Refraction Combined with Rotatory Power.* **C. Kraft** and **C. Zakrzewski.** (Acad. Sci. Cracovie, Bull. 10. pp. 508–533, Dec., 1904.)—An elaborate mathematical examination of this optical case, illustrated by numerous diagrams, without reproduction of which it is difficult to explain briefly. [See also Abstract No. 1387 (1904).] E. H. B.

1229. *New Standards of Wave-length.* **H. Kayser.** (Astrophys. Journ. 20. pp. 327–330, Dec., 1904.)—The conclusions dealt with in Abstract No. 1348 (1904) are reaffirmed. E. C. C. B.

1230. *Reflection of Light near the Polarising Angle.* **R. C. Maclaurin.** (Roy. Soc., Proc. Ser. A. 76. pp. 49–65, April 22, 1905.)—A mathematical theory of the reflection of light near the polarising angle, whose results are represented by graphs on a diagram in comparison with those of the theory of Fresnel, from which they differ, and with the experimental results of Jamin, with which they agree. E. H. B.

HEAT.

1231. *Density of Carbon Dioxide at* 2,000° C. **F. Emich.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 85–103, Jan., 1905. From the Laborat. f. allgem. Chemie an der k.k. techn. Hochschule in Graz.)—A continuation of an investigation into the density of gases at very high temperatures by measuring their effusion rates through a heated iridium tube [see Abstract No. 1971 (1904)]. The tube was glazed with a fused layer of zirconium and yttrium oxides in order to prevent its being damaged ; the temperature was optically measured. It was found that the ratio of the effusion rates of carbon dioxide and nitrogen is the same at 2,000° C. as at ordinary temperatures, and it therefore appears that no dissociation can occur in the former gas at this temperature. E. C. C. B.

1232. *Empirical Relation between the Densities of any Two Liquids.* **K. Schaposchnikow.** (Zeitschr. Phys. Chem. 51. pp. 542–546, April 25, 1905.) —The liquids are considered as exposed to the pressures of their own saturated vapours ; the densities are taken at temperatures equi-distant from the critical temperatures of the bodies. The empirical relationship suggested is expressed by the following linear equation : $\delta_T = n . \delta_{T'} + b$, where d_T and $d_{T'}$ are the densities of the two substances, δ_T and $\delta_{T'}$ are the temperatures at which the densities are taken, n and b are constants for each two substances. The formula was tested for the following pairs : (1) Benzene and stannic chloride, (2) heptane and fluorbenzene, (3) pentane and heptane, (4) pentane and alcohol, (5) pentane and carbon dioxide, and found to be exact almost to the critical point. D. H. J.

1233. *Thermal Conductivity of Gaseous Phosphorus Pentachloride.* **C. Feliciani.** (Accad. Lincei, Atti, 14. pp. 371–377, April 2, 1905.)—Determinations, by the method of cooling, of the thermal conductivity of gaseous phosphorus pentachloride at pressures of 1 atmosphere and 100 mm., and between the temperatures 145–300° C., show that, compared with that of hydrogen under the same conditions, the conductivity is irregular, being approximately proportional to the coefficient of dissociation—a result analogous to that obtained with nitrogen peroxide [see Abstract No. 1694 (1904)], and in perfect harmony with the kinetic theory of gases. W. H. Sr.

1234. *Method of Determining Heat-conductivity.* **C. Niven.** (Roy. Soc., Proc. Ser. A. 76. pp. 34–48, April 22, 1905.)—If a long circular cylindrical shell be heated by the passage of a uniform electric current along a uniform wire coinciding with its axis, then, when the steady state is attained—

$$H = -2\pi rk d\theta/dr,$$

H being the heat supplied by the wire per cm. per sec., θ the temperature at distance r from the axis, and k the conductivity. Thus, if the difference of temperature is τ between points at distances a and b cm. from the axis, when i amps. pass along the wire on which the potential-difference is e volts for a length of l cm., $k = ei \log(b/a)/8{\cdot}4\pi\tau l$. Experiments were made on different woods, plaster of Paris, sand, garden mould, and sawdust, two moulds in the form of half cylinders being filled with the material to be tested and then squeezed tightly together to form a complete cylinder, the heating axial wire and two platinum wires or thermo-couples parallel to it for the measurement of temperature having first been placed in position in the surface of contact. Mathematical solutions of seven cognate problems are also worked out, from one of which it appears that in the experiment with sand τ was yet 5 or 1 per cent. below its steady value after a lapse of 1½ or 7½ hours respectively.

R. E. B.

1235. *Lowest Temperature of Evaporation of Metals in the Vacuum of the Kathode Light.* **F. Krafft** and **L. Bergfeld.** (Ber. Deut. Chem. Gesell. 38. pp. 254–262, Jan. 21, 1905.)—The authors describe how this temperature may be exactly determined. They use a horizontal tube 25 cm. in length, and connected at one end to the pump and cooled receiver, while the other is surrounded by a mantle in which the heating fluid is circulated; in some cases the tube must be of quartz. In this way the lowest temperature of evaporation is found to be 156·5° for cadmium, 680° for silver, and so on. [See also next Abstract.]

T. H. P.

1236. *Boiling-point in Vacuum: a New Constant and its Meaning.* **F. Krafft.** (Ber. Deut. Chem. Gesell. 38. pp. 262–266, Jan. 21, 1905.)—Mercury begins to evaporate at —40°, boils in vacuum at 155°, and under the ordinary pressure at 357°. Hence the interval (195°) between the commencement of evaporation and the point at which the liquid boils in vacuum, during which work is done in overcoming gravity, is approximately equal to that (202°) between the boiling-points in vacuum and at the ordinary pressure, during which work is done overcoming the pressure of the atmosphere. The author's experiments show that this relationship also holds for other metals. In general, starting from the commencement of evaporation, as much heat is required to overcome the resistance of gravity as is further required to overcome the pressure of the atmosphere, *i.e.*, gravity and atmospheric pressure are equivalent at the surface of the earth. The results obtained are given in the following table, where I. represents the temperature at which evaporation begins in vacuum, III. the boiling-point in vacuum, and V. the boiling-point under 760 mm. pressure.

	I.	Diff.	III.	Diff.	V.
Mercury	— 40°	195°	155°	202°	357°
Cadmium............	156	294	450	299	749
Zinc	184	366	550	370	920
Potassium	63	302	365	302	667
Sodium...............	98	320	418	324	742
Bismuth	270	723	993	707	1700
Silver	680	680	1360	680	2040

[See also preceding Abstract.]

T. H. P.

1237. *Light Emission and Melting-points of some Metals.* **L. Holborn** and **F. Henning.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12. pp. 311–317, March 9, 1905. Communication from the Physikal. Technische Reichsanstalt.) —The readings of optical pyrometers are generally referred to the radiation of the standard black body, and progress in optical pyrometry requires a determination of the emission of different substances as compared with that of the black body. Platinum, gold, and silver are investigated, platinum by assuming that $(1/S)-(1/T)$ is constant, where T is the absolute temperature of the metal and S that of the black body for a given colour, both substances being equally bright. A calculation from Wien's law gives the ratio E_m/E_s of the emissions of the metal and the black body, viz.—

$$\log_e(E_m/E_s) = 14500(1/T - 1/S)/\lambda,$$

and values of S and T from previous work [see Abstract No. 1196 (1903)] lead to $E_m/E_s = 0·319$. The ratio found from the reflecting power of the metal by means of Hagen and Rubens' numbers is 0·340. Gold and silver were investigated at their melting-points, there being no noticeable change in the emission of light at these temperatures, and it was found that of the red rays platinum emits about 1/3, gold 1/8, and silver 1/14 of that emitted by the black body. The melting-point of Pt found by means of the optical pyrometer was 1,729° and 1,718° C., according to the constant used, that of palladium 1,549° and 1,540°, the values given by thermo-couples being 1,710° and 1,535° C. respectively. G. E. A.

1238. *Specific Heat of Water and the Mechanical Equivalent of Heat.* **C. Dieterici.** (Ann. d. Physik, 16. 4. pp. 593–620, April 11, 1905.)—The author's work as regards water [see Abstract No. 123 (1905)] is here again fully recounted. An experimental determination of the mass of mercury that is drawn into a Bunsen ice-calorimeter for every mean (Bunsen) calorie that enters is described, this mass being found to be 0·015491 gm. Also by passing a current through a wire which is used as the source of heat in an ice-calorimeter, the heat corresponding to the entrance of 0·015491 gm. into the calorimeter (*i.e.*, to a mean calorie, with the above determination) is found to be 4·1925 joules. R. E. B.

1239. *Latent Heat of Evaporation of Benzene and some other Compounds.* **J. C. Brown.** (Chem. Soc., Journ. 87. pp. 265–269, March, 1905.)—Employing the electrical method previously described [see Abstract No. 1986 (1904)], the following results have been obtained for the respective latent heats of evaporation :—

Benzene	94·93	Mesitylene	74·42
Toluene	87·43	Cymene	67·64
o-Xylene	82·47	Tertiary amyl alcohol	115·65
m-Xylene	81·34	Propyl isovalerate	64·37
p-Xylene	80·98		

W. H. Si.

1240. *Comparison of the Platinum Scale with the Normal Scale of Temperature between* 444° *and* −190°. **M. W. Travers** and **A. G. C. Gwyer.** (Roy. Soc., Proc. 74. pp. 528–538, April 10, 1905.)—The parabolic formula of Callendar, connecting the platinum and normal temperature scale—

$$\Delta = \delta(T/100 - 1)T/100,$$

is known to give inaccurate results when applied to very low temperatures if the same value of δ as that applicable to higher temperatures is used. The present paper describes experiments undertaken to determine the correct relation between the two scales down to temperatures of −190° C. The experiments partially overlap the work of Callendar and Griffiths and of

Harker and Chappuis, and the results are subjected to comparative discussion. The result arrived at is that by comparison with the constant-volume hydrogen thermometer for the range from —190° to 34° the value of δ should be 1·90, while Callendar and Griffiths for the range from 0° to 444° had found $\delta = 1{\cdot}50$ by comparison with the constant-pressure air thermometer, the value of Chappuis and Harker from —23° to 445° being 1·54 by the constant-volume nitrogen thermometer. The comparisons of the present authors were made at the ice and steam points, and in liquid air and in a mixture of solid carbonic acid and alcohol. In both of the latter baths a sufficiently constant temperature was obtained by special methods, for details of which reference must be made to the original paper. W. Ros.

1241. *Loss of Heat from Incandescent Filaments.* **S. Tereschin.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 37. Part I. pp. 15–18, 1905. Phys. Zeitschr. 6. pp. 217–219, April 1, 1905.)—In connection with Hartmann's work [see Abstract No. 3217 (1904)], the author refers to his own work on similar lines published eight years ago in a Russian journal, from which he gives extracts. The loss of heat, Q, from a platinum wire is expressed by—

$$Q = A(T^4 - T_0^4) + B(T - T_0)^{\frac{5}{4}},$$

by an application of Stefan's and Lorenz's laws for the respective losses due to radiation and to conduction and convection, T and T_0 being the absolute temperatures of the wire and of the surrounding medium. The results of Hartmann and of the author show that the above formula holds for Pt wires between 200° and 1,500° C. G. E. A.

1242. *Conduction Losses from Incandescent Carbon Filaments in Various Gases.* **L. W. Hartmann.** (Phys. Rev. 20. pp. 322–332, May, 1905.)—Describes experiments on the power required to raise the filament of an incandescent lamp to various known temperatures when the lamp is filled with dry hydrogen, nitrogen, and carbonic acid gases respectively, and when the lamp is exhausted. The temperature measurements were made by the method described in Abstract No. 3217 (1904). Curves plotted from the results obtained show that the conduction losses are greatest in hydrogen, carbon dioxide, nitrogen and in vacuo, following in that order; the results for carbon dioxide are, however, only regarded as approximate, as chemical action set in and at high temperatures the carbon filament burnt off. Tabulated statements of the conduction losses and a formula for expressing the same are given and discussed. W. Ros.

1243. *Extension of Fontaine's Theory on the Heat of Vaporisation of a Liquid Charged with Electricity.* **S. Sano.** (Mathematical and Physical Soc., Tokyo, 2. 18. pp. 277–279, 1904.)—E. Fontaine calculated the heat of vaporisation of a liquid charged with electricity on the surface of separation between the liquid and its vapour. The present paper extends the problem to the case in which the dielectric constant of the vapour differs from that of vacuum. The mathematical methods and notation are nearly the same as those in the paper dealt with in Abstract No. 1054 (1905). E. H. B.

1244. *Vapour Pressures, especially of Solids, according to K. Stelzner and G. Niederschulte.* **E. Wiedemann.** (Deutsch. Phys. Gesell., Verh. 7. 7.

pp. 159–162, April 15, 1905. Phys. Inst. d. Univ., Erlangen, Jan., 1905.)—In the determination of vapour pressures at low temperatures, Niederschulte uses a glass U-tube, in which the substance is loosely arranged and which is kept at a constant temperature. After a known volume of air is passed through the tube, the loss of weight is determined and the vapour pressure calculated from this. Stelzner's apparatus for the high temperature measurements consists of two wide glass tubes, one vertical and the other horizontal, connected by a narrow tube. The vertical tube contains the substance and a thermometer, while the horizontal tube is kept cool. The temperature of the former tube is gradually raised until, when the sublimation temperature is reached, sublimation of the substance suddenly takes place in the horizontal tube. The temperature is then read off, and also the corresponding pressure. The values obtained by these two methods for mercuric chloride, bromide, and iodide, and for mercurous chloride and iodine are in good agreement, but differences are observed for anthracene, probably owing to the substances used being of unequal purity. The curves plotted from the results are similar to those obtained with liquids, and are all exponential. The curves for the different substances are not parallel to one another, so that Dalton's law is not obeyed. With the haloid salts of mercury, the vapour pressure diminishes as the molecular weight increases, a behaviour which is analogous to that of the halogens and also that of the homologous series of alcohols, esters, and organic acids. T. H. P.

1245. *Vapour Pressures of Mercury and Sodium.* **A. Gebhardt.** (Deutsch. Phys. Gesell., Verh. 7. 8. pp. 184–188, April 30, 1905. Communication from the Phys. Inst. der k. Univ., Erlangen. Extract of Dissertation.)—For determining the vapour pressures of mercury and sodium, the author uses the dynamical method, the temperatures being measured at which the metal boils under different pressures determined by a manometer. The numbers obtained for mercury agree well with the results of other observers and with the values calculated from Jewett's measurements of the vapour densities of mercury [see Abstract No. 554 (1903)]. The vapour pressures obtained by the author for sodium differ enormously from those calculated from Jewett's numbers (*loc. cit.*); this is explained by the fact that these latter were obtained from experiments in vessels of glass, which is vigorously attacked by the sodium. The author uses porcelain vessels. T. H. P.

1246. *Fundamental Functions of One-Component Ideal-Constituent Gases.* **J. M. Bell** and **J. E. Trevor.** (Journ. Phys. Chem. 9. pp. 179–209, March, 1905.)—Some idea of what the authors mean by this truly formidable title may be gained by saying that it applies, for example, to such gaseous equilibria as $N_2O_4 \rightleftarrows 2NO_2$, provided the constituents behave as ideal gases. The authors work out in the Gibbsian manner the thermodynamics of such systems in a precise, exhaustive, and perfectly systematic fashion. Tabulated lists of thermodynamic relationships and derivatives of functions are given. F. G. D.

1247. *Thermodynamic Potentials.* **W. P. Boynton.** (Phys. Rev. 20. pp. 259–267, April, 1905.)—In continuation of a former paper [see Abstract No. 512 (1901)], but with a changed datum for the reckoning energy and with restricted reference to monatomic gases, curves giving the *reduced* values of $\psi \equiv E - T\phi$ in terms of ν for constant values of ϑ, of $\zeta \equiv E - T\phi + pv$ in terms of ϑ for constant values of π, of $\chi \equiv E + pv$ in terms of π for constant values of ϕ, and curves representing reduced isopiestics and isentropics on a $\nu\vartheta$-diagram, reduced isometrics and isentropics on a $\pi\vartheta$-diagram, and reduced isometrics and isothermals on a $\pi\phi$-diagram, are given. Some of the peculiarities of the curves are pointed out. R. E. B.

1248. *Pressure of Gases and the Virial Equation.* **Rayleigh.** (Phil. Mag. 9. pp. 494–505, April, 1905.)—The method of dimensions is applied to the virial equation, the attraction between two molecules being taken to vary inversely as r^n, and it is shown that in this case n must be greater than 4. By application of the method of dimensions to the virial equation a possible theoretical foundation is discovered for the empirical conclusion that the temperature should be introduced into the denominator of the cohesional virial, and this empirical conclusion seems to indicate that the molecular forces are intrinsically as much repellent as attractive, *i.e.*, such as are due to electric or magnetic doublets. That in this case there is a preponderance of attractive over repulsive virial is shown from consideration of the time for which any particular value of the virial prevails. It thus appears that there is good reason to doubt that the relation of pressure to temperature, with volume constant, is accurately linear, even at high rarefactions, though such relation is approximately satisfied. The characteristic equation then being taken of the form $p = T\,\phi(v) + \chi(v) + \psi(v, T)$, a method is suggested of investigating the supplementary term ψ. R. E. B.

REFERENCES.

1249. *Test of a Liquid-Air Plant.* **W. P. Bradley** and **A. W. Rowe.** (Phys. Rev. 19. pp. 330–343, Nov., 1904. Contribution from the Cryogenic Laboratory of Wesleyan University.)—See also Abstract No. 226 (1903).

1250. *Methods of Temperature Indication.* **E. J. Baty.** (Soc. Chem. Ind., Journ. 24. p. 307; Discussion, pp. 307–308, April 15, 1905.)—A useful classification, with brief outline of the different methods, more especially with reference to rough-and-ready works methods.

1251. *Uehling's Pneumatic Pyrometer.* (Electrochem. Ind., N.Y. 3. pp. 160–161, April, 1905.)—The Uehling pneumatic pyrometer with Steinbart automatic recorder has found favour in iron and steel plants, especially for indicating and regulating the temperature of the hot blast for furnaces. It is made by the Uehling and Decker Co., of Passaic, N.J. A detailed description with diagrams is given of the instrument and recorder. A simple portable type is also described. [See also Abstract No. 1780B (1904).] W. W. H. G.

1252. *Thermodynamics.* **K. v. Wesendonck.** (Phys. Zeitschr. 6. pp. 50–52, Jan. 15, 1905.)—The author considers the transformation of chemical energy into mechanical work, and dissents from some of Orr's views. [See Abstract No. 130 (1905).] R. E. B.

1253. *Generalisation of a Formula in the Kinetic Theory of Gases.* **E. Bose.** (Ann. d. Physik, 16. 1. pp. 155–159, Jan. 26, 1905.)—The kinetic theory can take the energy of radio-activity into account as part of the atomic energy provided that it is independent of the temperature, as seems to be the case with radium emanation. R. E. B.

SOUND.

1254. *Pressure of Sound Waves.* **R. W. Wood.** (Phys. Rev. 20. pp. 113–114, Feb., 1905. Phys. Zeitschr. 6. p. 22, Jan. 1, 1905.)—A radiometer with six wings of mica is mounted on a needle-point and placed near the focus of a concave mirror such as is used for concentrating heat-rays. A source of sound, such as a torrent of electric sparks, is placed in the conjugate focus. The radiometer turns with great speed when the sound waves are concentrated on one side of it. **S. Skinner.** (Nature, 71. p. 609, April 27, 1905.)—Skinner points out that the above experiment may be interpreted as exhibiting the effects of a series of explosive impulses rather than a continuous train of waves. A jar discharge produces in air a violent explosive effect due to the repulsion between constituents of the current in opposite phase to one another. E. E. F.

1255. *Velocity of Sound in Tubes.* **J. Sturm.** (Ann. d. Physik, 14. 4. pp. 822–837, Aug. 2, 1904. Extract from the Bonn Dissertation.)—The method is similar to that of Kayser and Müller [see Abstract No. 1472 (1904)], in which a transversely vibrating steel rod sets up air vibrations in Kundt tubes. It is found that the Kirchoff formula is not valid either in its relation to tube width or to frequency. The γ of the formula is not a constant, and cannot be taken at the value given by thermodynamic theory. J. W. P.

1256. *Vibration of Resonance Boxes.* **T. Terada.** (Mathematical and Physical Soc., Tokyo, 2. 20. pp. 312–315, 1905.)—The author investigates the manner in which the surfaces of a resonance box take part in the vibration. When the fork of a resonance box is plugged, and a fork of the same pitch is placed on the wood, the resonance varies with the point of contact, the points of maximum resonance being situated on an oval which is eccentric towards the open end of the box. With a fork of higher pitch, the oval becomes narrower. The author shows by several experiments that the oval is a nodal line, and not the centre line of a loop or ventral segment. When the fork attached to the centre of the box is sounded, and a heavy iron bar is pressed on the box, the sound is not influenced when the end of the bar is on the oval line, but it is deadened when it is placed in the centre of the oval. A box of harder material gives a wider oval, as shown by substituting magnolia for pine. The principle of maximum resonance at nodal lines may be employed for finding the nodal lines of bells and other curved shells, where sand figures cannot be obtained. The author finds that a small perforation near the closed end of the box increases the resonance. E. E. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1257. *Electrodynamics in Moving Media.* **R. Gans.** (Ann. d. Physik, 16. 3. pp. 516–534, March, 1905. Phys. Inst., Tübingen, Jan. 22, 1905.)—Among the more important results of this mathematical paper are the following: (1) The motion of the earth has no influence on the phenomena of dispersion and absorption. (2) In the case of circular polarisation the earth's motion has no effect on radiation in isotropic naturally active media. (3) The theory of Cohn as here extended is in agreement with the experiments of Mascart, repeated with greater accuracy by Rayleigh. (4) In the space outside electrons the field strengths are identical according to the theory of Lorentz and that of Cohn. (5) Whereas according to Abraham the longitudinal masses are different for surface density and volume density, this is not the case on the theory of Cohn; but the dependence on the velocity is the same according to both theories. E. H. B.

1258. *Generalisation of the Formulæ Expressing the Distribution of Potential in a Heterogeneous Medium.* **A. Petrowsky.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 37. 3. pp. 49–61, 1905.)—The author demonstrates the following theorem: If there are any two surfaces $f_0 = 0$ and $f_n = 0$, communicating with sources of constant potential V_0 and V', and if we have obtained a function V, which expresses the distribution of the potential when all the space between the two surfaces is homogeneous (filled with air), it is then possible to find the functions which express the distribution of the potential when the space is divided into n parts by surfaces $f_1 = 0, f_2 = 0, \ldots f_{n-1} = 0$—each part being filled with matter having the dielectric constant successively $K_1, K_2, \ldots K_n$ and the surfaces of separation coinciding with the equipotential surfaces. Let us suppose that the potential has the constant values $[V]_1$, $[V]_2, \ldots [V]_{n-1}$ at these surfaces, and a value V at any point whatever situated between $f_{k-1} = 0$ and $f_k = 0$ in the first distribution, then the potential of this same point in the second distribution is expressed by the formula—

$$V_k = V_0 - \frac{\sum_{i=1}^{i=k-1} \frac{[V]_{i-1} - [V]_i}{K_i} + \frac{[V]_{k-1} - V}{K_k}}{\sum_{i=1}^{i=n} \frac{[V]_{i-1} - [V]_i}{K_i}} (V_0 - V').$$

The capacity of the system is increased in this case in the proportion—

$$(V_0 - V') \Big/ \sum_{i=1}^{i=n} \frac{[V]_{i-1} - [V_i]}{K_i}.$$

In 1900 the author deduced a number of formulæ which are only special cases of the above general theorem. D. H. J.

1259. *Maxwell's Stress Theory.* **V. Bjerknes.** (Phil. Mag. 9. pp. 491–494, April, 1905.)—The actions between pulsating bodies immersed in a liquid conform to a law similar to that of Coulomb with respect to the actions between electrified bodies or magnetic poles, only with reversed sign. Can they therefore be explained as due to Maxwell stresses in the medium, only with reversed sign, though actually due to isotropic stress in the liquid? No; because the Maxwell stresses presume a static phenomenon, and the pulsations are kinetic. Hence, too, the question of the reality of the Maxwell stresses in the case of electrical and magnetic phenomena is closely related to the question whether these phenomena are of a static or kinetic nature; now Maxwell considers magnetic phenomena to be kinetic, so that in their case at least the reality of the Maxwell stresses cannot be concluded, and the real stresses may be of much simpler character, as with the pulsation phenomena. R. E. B.

1260. *Attraction of Electric Doublets.* **H. Nagaoka.** (Mathematical and Physical Soc., Tokyo, 2. 20. pp. 316–320, 1905.)—Starting from Kelvin's Æpinus atom, consisting of a number of electrons combined with a single positive particle of equivalent charge, and moving around it in circular orbits lying in the same plane, the author takes two such atoms, and considers their mutual action. This is analysed into—(*a*) a repulsion between the central charges; (*b*) an attraction of each positive particle by the negative electrons of the other atom; and (*c*) a repulsion between the two sets of revolving electrons. The distance between the atoms is supposed to be great compared with their dimensions. Expressions for the value of these forces are then obtained. Summing up these four forces, a result is obtained which shows that the force is nearly inversely proportional to the fourth power of the distance between the atoms. Each atom is equivalent to a small magnet of moment $= Ea^2\Omega$, and two such small magnets attract or repel each other inversely as the fourth power of the distance. Thus both the electrostatic and magnetic actions give rise to forces proportional to the inverse fourth power of the distance between the atoms, and when the atoms make up molecules the action will be jointly proportional to their respective masses, or to the amount of positive and negative charges in the molecules. E. E. F.

1261. *Field of a Rotating Electron.* **A. H. Bucherer.** (Phys. Zeitschr. 6. pp. 225–227, April 15, 1905. Phys. Inst. d. Univ., Bonn, March, 1905.)—In the theory of magnetism the rotating electron plays a fundamental part. But hitherto a calculation of its electromagnetic field has not been made. The problem is here dealt with and expressions obtained for the energy of the internal and external fields. The total energy is given by—

$$W_m = e^2 w^2 R / 36 v^2 \pi,$$

in which R is the radius of the electrons, e the charge, and w its angular velocity. E. H. B.

DISCHARGE AND OSCILLATIONS.

1262. *Disruptive Discharge in Liquids.* **K. Przibram.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. pp. 1303–1316, Nov., 1904. From the Inst. f. theoret. Physik an d. k.k. Univ. in Wien.)—In the experiments here described the spark from a spark-inductor is allowed to pass in a chemically pure liquid from a platinum wire—fused into glass with a few mm. protruding—to an insulated disc, the longest spark being measured both when the wire is positive and when it is negative. The results exhibit the following regularities: In a homologous series of liquids the length of spark diminishes as the molecular weight increases, the diminution being more rapid for the longer positive sparks than for the negative ones; in the case of the alcohols the high conductivity of the lower members exerts a disturbing influence. The introduction of a halogen atom or an amino-group into benzene is accompanied by a considerable elongation of the sparks, especially of the positive ones. Oxygenated compounds also appear to yield longer sparks than the corresponding hydrocarbons; with these compounds the negative sparks are quite as long as, and in some cases considerably longer than, the positive ones. All the liquids decompose and evolve gases, even when there is only a glow at the point. The evolution of gas takes place along the whole path of the discharge, as may be readily seen with glycerine in which the bubbles are only slowly removed from the positions in which they are formed. T. H. P.

1263. *Union of Hydrogen and Oxygen at Low Pressures through the Passage of Electricity.* **P. J. Kirkby.** (Phil. Mag. 9. pp. 171–185, Jan., 1905.)—It has been previously shown by the author [see Abstract No. 1127 (1904)] that partial union of hydrogen and oxygen occurs when a luminous discharge is passed through a mixture of equivalent proportions of the gases at low pressures, and that if the pressure and the potential difference of the plates remain steady during the discharge, the quantity of water vapour formed is proportional to the quantity of electricity passing. It was found, moreover, that if Δp mm. is the fall of pressure associated with the passage of ΔQ coulombs at the pressure p mm. and X the voltage difference of the plates during the discharge, then, $(1/p)(\Delta p/\Delta X)$ is a function of X/p. The experiments now described are for the purpose of deciding, first, how changes in the distance between the parallel electrodes, between which the discharge takes place, affect the results, and, secondly, whether the same effects are observed if non-oxidisable plates are used. The results show that $\Delta p/\Delta Q$ is independent of the distance between the plates, and that the function is approximately linear and is expressed by the straight line, $\Delta p/\Delta Q = pD\ 10 + 3X/800$, where D is the distance between the plates; the errors arising when the fall of pressure is considerable are calculated. Taking W as the number of molecules of water vapour whose formation is connected with the passage to the electrodes of each pair of ions, it is found that $W = 4\,(pD/100 + 3X/800)$, an equation which is independent of the capacity of the apparatus. The probable physical interpretation of this expression is given. T. H. P.

1264. *Kathode Rays of Various Origin.* **R. Reiger.** (Deutsch. Phys. Gesell., Verh. 7. 6. pp. 122–124, March 30, 1905. Phys. Inst. d. Univ., Erlangen, March, 1905.)—Kathode rays from insulators and those originating in gases themselves were investigated, and their values of ϵ/μ found by Lenard's method [see Abstract No. 1845 (1900)]. The result is that universally, wherever kathode rays are formed, the order of magnitude of ϵ/μ is the same (subject to variations, as Kaufmann has shown, with the velocity of the rays). This shows that we must conclude in favour of the simplicity of the electrical atom in contrast to the complexity of the atom of matter. A. D.

1265. *Dispersion of Electricity in Iodine Vapour.* **A. Campetti.** (Accad. Sci. Torino, Atti, 40. 1. pp. 55–64, 1904–1905.)—The author has made experiments with a view to (1) measuring with exactitude the conductivity of a gas, other than air, at high temperatures, (2) studying the influence of the nature of the electrodes on the ionisation of a gas; it was especially important to consider the effect of chemical action between the gas and the electrode on the course of the ionisation. The experiments consisted in noting the rate of the dispersion of electricity from the positive and from the negative electrode in air and in iodine vapour, with electrodes (*a*) of Pt, (*b*) of Ag, at various temperatures obtained with a gas stove. The tables of data show that (1) with Pt electrodes and for temperatures up to about 500° C., the dispersion in both air and iodine is greater for negative electricity than for positive; (2) in air the dispersion is the same whether the electrode is of Ag or Pt; (3) in iodine vapour the dispersion is much greater with Ag than with Pt electrodes, and (as was confirmed by repeated experiments) is greater for positive than for negative electricity. D. H. J.

1266. *Glow in Evacuated Tubes under Friction.* **C. Hess.** (Phys. Zeitschr. 6. pp. 200–201, April 1, 1905.)—An electrodeless tube is held on one conductor of an influence machine while its other end is brought near the second conductor. When this end is touched by the free hand, the shock received is simultaneous with a lighting-up of the tube. Further, the tube may be made to glow continuously if the hand is passed lightly over its surface, the first appearance of the glow depending on the condition of hand and tube. Röntgen tubes, Geissler tubes, glow-lamps, and Torricellian vacua can all, without exception, and with more or less difficulty, be made to glow by this means. G. E. A.

1267. *Extent of Kathode Glow.* **N. Hehl.** (Phil. Mag. 9. pp. 614–617, April, 1905. Communication from the Phys. Inst. of the Univ. of Erlangen.) —Some of the results given in this paper have already appeared in Abstract No. 563 (1903). Additional conclusions arrived at are as follows: The current density at the kathode is directly proportional to the pressure, *i.e.*, $i/2\pi rlp =$ const., where r is radius of the wire electrode, l the length of it covered by the glow, and p the pressure. The constant is 0·33 for platinum, and 0·47 for aluminium if r is given in milliamps., l and r in cm., and p in mm. of mercury. This formula holds only for nitrogen. In the general case p must be replaced by p^n, *e.g.*, $n=2$ for hydrogen. If d is the thickness of the canal-ray layer, the kathode dark space, or the negative glow layer, then, if the electrode is not completely covered, it is found that $pd =$ const. The total intensity of the glow per unit of current remains the same at all pressures, so long as the kathode is not completely covered. R. S. W.

1268. *Discharge of Electricity from Hot Platinum in Phosphorus Vapour.* **O. W. Richardson.** (Phil. Mag. 9. pp. 407–413, April, 1905.)—If clean platinum wire be heated to redness, the author has shown that there is an emission of positive electricity which decreases asymptotically with the time. If the wire stands in a vacuum or is exposed to the vapours from mercury or tap-grease no appreciable recovery takes place. Contact with the vapours from phosphorus pentoxide causes a very large increase in the leak. This has been shown by various experiments to be due to the vapours of phosphorus present as an impurity in the P_2O_5. The effect increases also if a cold wire is left exposed to the vapour, and pumping out this vapour does not reduce the activity proportionally to the decrease of the pressure. It is therefore probable that it is connected with the absorption of the phosphorus by the platinum. R. S. W.

1269. *Method of Strengthening and Facilitating Electrical Discharges.* (Zeitschr. Instrumentenk., Beib. 7. p. 70, April 1, 1905.)—The article relates to the German patent of A. Williams. To facilitate the discharge taking place a very high resistance shunt is provided for a small portion of the discharge. This shunt can either be a body of very high specific resistance, placed near or touching one or both electrodes; or a similar body may be placed in proximity to one spark-ball, with a metallic connection extending to the neighbourhood of or just touching the other spark-ball; or a bare conductor may be placed so that one end is close to one of the electrodes, the remaining portion of the conductor being directed away from the line of the spark-gap (British Patent No. 175 of 1903). [See also Bowlker, Abstract No. 386 (1905).] L. H. W.

1270. *Reflection of Kathode Rays.* **E. Warburg.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 22. pp. 458–464, April 27, 1905.)—Kathode rays are reflected from thin as they are from thick sheets of metal until the difference of potential between the anode and the kathode reaches a certain critical value, which for aluminium sheets of 0·53, 1·90, and 2·44 μ thickness, is 11,000, 16,500, and 21,800 volts respectively; and for copper, 0·66 μ thick is something above 27,800 volts. For rays produced under these respective differences of potential, the thickness of the metal which takes part in the process of reflection is accordingly 0·53, 1·90, and 2·44 μ for aluminium, and something less than 0·66 μ for copper. A. D.

1271. *Effect of Electric Waves on Filings Coherers.* **T. Gnesetto** and **P. Frasson.** (Real. Istit. Veneto, Atti, 63. pp. 703–725, 1904.)—The authors have repeated Mizuno's experiments [see Abstract No. 384 (1901)], with special precautions as regards the preparation and uniformity of size of the grains. Equal quantities of filings of different metals, made up into coherers in the same way as before, were exposed to the influence of waves produced by a coil having a pendulum interrupter, the resistance being measured after each emission. It was found that Zn, Cd, Sb, Cu, and Sn showed little further diminution of resistance after the first emission; Zn, Ni, and Fe give, however, variable results for each single exposure. As regards the relation pointed out by Mizuno, as existing between the diminution of resistance, melting-point, and electrical conductivity, the present results are chiefly confirmatory, as can be seen from the following:—

	Resistance after Coherence.	Melting-point.	Specific Conductivity.
Iron ...	3325 ohms	1600°	10·2
Bismuth	1175	260	0·75
Zinc ...	357	420	17·54
Cadmium	138 ohms	315°	14·33
Copper...	65	1100	62·11
Tin	33	238	7·57

The exceptions (Bi and Cu), however, possess abnormal conductivities (very low and very high respectively). All the same, the authors do not think Mizuno's hypothesis generally applicable; the relations at the points of contact are held to be of greater importance than the nature of the metal; no definite results could be drawn from experiments to test this point. Diminution of the size of the grains raises the value of the resistance after coherence; reducing the diam. of the containing tube, still more markedly. The fusion theory of Lodge is considered to well explain the results. L. H. W.

1272. *Simple Method of Studying the Oscillatory Spark Discharge.* **G. A. Hemsalech.** (Comptes Rendus, 140. pp. 1103–1105, April 17, 1905.)—When a current of air is directed upon an oscillatory spark discharge, the individual oscillations are separated out from one another. The arrangement employed by the author consists of two wedge-shaped copper electrodes set vertically in the same plane and at a slight angle to one another. Upon the top of each electrode a fine wire is fixed, which projects a little beyond the edge. The distance beyond these two wires is about 3 mm. The discharge is made to pass between these wires, and a powerful blast of air is directed downwards upon the sparks from a glass tube, 3 mm. diam., placed 3–6 mm. above the wires. The sparks are produced by the discharge of a plate condenser with self-induction, charged by a transformer; from 20 to 30 sparks pass per sec. When the air-blast is turned on it is found that the initial spark in each case, and the first 6–10 oscillations, pass between the wires, but the succeeding 10 oscillations are carried down by the air-current and pass between the copper wedges. If the air-current is perfectly constant these latter oscillations remain in a constant position and may be photographed. From a knowledge of the speed of the air-current, measurements may be made of the frequency of the oscillations. Photographs of the discharge are given under the following conditions: 4 plates in the condenser, each with a capacity of 0·0008 mfd.; self-induction 0·042 henry, air-current 36 m. per sec.; the number of oscillations was 27,400 per sec. The inclination of the oscillations gives a means of finding the velocity of the nitrogen ions carrying the charge; this velocity is 29 m. per sec.; it diminishes with increase of the capacity of the condenser, and is directly proportional to the frequency of the oscillations. E. C. C. B.

1273. *Effect of Eddy Currents and of Hysteresis on Oscillatory Sparks.* **G. A. Hemsalech.** (Comptes Rendus, 140. pp. 1322–1325, May 15, 1905.)—Using the method described in the preceding Abstract, the author has studied the effect of introducing into an inductively-wound coil a cylinder of sheet zinc. This cylinder, progressively inserted, produces a progressive increase of the oscillation frequency (25,000), rising to a maximum (50,000) when it is completely within the coil; but the number of oscillations per discharge remains constant. A slit cylinder of zinc produces no effect, since the eddy currents are prevented from circulating. A sheet-iron cylinder similarly introduced causes all the oscillations to be suppressed except the first; a small increase of frequency (1·3 times, about), due to eddy currents, is observable. With the iron cylinder slit longitudinally the suppression of the oscillations is practically the same as with the whole cylinder, but the frequency is slightly *diminished* (about 5 per cent.), as Marchant has found [see Abstract No. 2231 (1900)]. When the oscillations have been suppressed by the iron, on then inserting the zinc cylinder between the iron and the coil the oscillations reappear with the increased frequency due to the action of the eddy currents. The illustrations show the results very clearly. L. H. W.

1274. *Resonance in Wireless Telegraph Circuits.* Part II. **G. W. Pierce.** (Phys. Rev. 20. pp. 220–251, April, 1905. Jefferson Phys. Lab., Harvard University, Dec. 26, 1904.)—The author has continued the work described in Abstract No. 806 (1905), inductive excitation being employed and the Fleming oscillation galvanometer used as receiving instrument as before. The present experiments deal with the effect on resonance, of variations of the length and form of the antennæ. The distance between transmitter and receiver is now 187 m., and antennæ 25 m. high could be used. Full details are given of the apparatus and methods employed, and of a further calibration of the oscillation galvanometer, and the experimental values obtained are tabulated; for these, reference must be made to the original. The author considers, from the results obtained, that the proper adjustment of the antennæ is of primary importance, and is not attained by making the mast circuits at the transmitter and receiver stations equal. Even with mast circuits comprising coils and antennæ of exactly the same dimensions it was found that it is quite possible to obtain the result that the energy in the side circuit at the receiving station is exceedingly small, while at the same time the capacity of the condenser in circuit must be made infinite to obtain resonance. The presence of more than one oscillation is indicated, as is usual with magnetic coupling; and the liability, if the circuits are not well understood, of possibly setting the receiver circuit to resonance with the feebler oscillation, is pointed out. Formulæ are deduced for the relation between capacity of antenna and the resonant capacity in the side circuit. L. H. W.

1275. *Infinite Metal Cylinder and Hertz Waves.* **W. Seitz.** (Ann. d. Physik, 16. 4. pp. 746–772, April 11, 1905. Phys. Inst., Würzburg, Jan., 1905.) —The reflection of electric waves by a metal surface is well known, and the action of a metal sphere has also been dealt with (J. J. Thomson's "Recent Researches"). But on account of its practical importance in connection with wireless telegraphy, the problem of the action of an infinite metal cylinder upon plane waves is here considered mathematically. The results may be summarised as follows:—First, *Wire Parallel to the Electric Force of the Waves.*—(1) The mean value of E^2 ($E =$ Electric Force) vanishes for a copper wire of 0·1 cm. radius, and for an iron wire of 2 cm. radius, and is reduced to 38·5 per cent. of its initial value for a platinum wire of 0·0002 cm. radius. (2) The mean value of E^2 varies with distance from the wire in the same way for the copper and iron wire, but differently for the very thin platinum wire. The action of the wire extends to a distance of several wave-lengths. (3) The mean value of E^2 is practically the same at the front and back of the wire, but is different from this at the sides. In these respects the thin platinum wire again shows a somewhat different effect. Second, *Wire Parallel to the Magnetic Force,* i.e., *Perpendicular to the Electric Force.*—(1) On the front and back surfaces of the copper wire of 1 mm. radius the radial and tangential components of the electric force are zero, while for the side surfaces the radial components are increased, the tangential component being vanishingly small. Hence, by means of the wire the electric lines of force are concentrated. (2) At very small distances from the surface the action of the wire on the waves vanishes. E. H. B.

1276. *Resistance of Metal Wires for High-frequency Currents.* **A. Broca** and **Turchini.** (Comptes Rendus, 140. pp. 1238–1241, May 8, 1905.—An account is given of an investigation as to how far the results of experiment agree with the values for the resistance to high-frequency currents, calculated from Kelvin's formula. The frequencies used ranged between 142,000 and $3{\cdot}8 \times 10^6$, obtained from condenser discharges, and the high-frequency dynamometer previously described [see Abstract No. 1417 B (1904)] was used to determine the high-frequency current values, the heat developed being at the same time measured calorimetrically. A continuous current producing the same heating was then passed through the wire; the ratio of the deflections obtained is that of the resistances offered by the wire in the two cases. The two forms of calorimeter are described and the precautions necessary. It was found that for non-magnetic metals (Cu and Pt) the divergences from values calculated from the formula $x = \rho\sqrt{4\pi c\omega\mu}$, where μ = permeability, c = conductivity in c.g.s. units, and $\omega = 2\pi/T$, are small; for values of $x < 8$ the heating is greater, and for $x > 8$ less, than is given by the formula. In the case of iron there was no agreement with calculated results, the figures obtained depending on the current passing; the heating is much less than that which would correspond to normal values of μ. If μ is taken as about 100, the results are comparable with the calculated values. German silver showed similar but less marked effects. The reason for the divergence in the case of the non-magnetic metals still requires explanation. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1277. *Mercurous Sulphate and Standard Cells.* **H. S. Carhart** and **G. A. Hulett.** (Amer. Electrochem. Soc., Trans. 6. pp. 109–126; Discussion, pp. 126–128, 1904. Zeitschr. Phys. Chem. 49. pp. 483–501, Sept. 13, 1904.)—The electrolytic method of preparing mercurous sulphate for use as a depolariser in the cadmium cell is fully described, and the conditions necessary to prevent hydrolysis of the salt are deduced from experiments on its solubility. Analysis of the completely hydrolysed product showed 84·3 per cent. of mercury and 10·50 per cent. of SO_4; these percentages do not show a very close agreement with the formula given by Gouy, $(HgOH)_2Hg_2SO_4$, which requires 86·02 per cent. of mercury and 10·32 per cent. of SO_4. However, it was found that the basic salt does not dissolve as such, but is decomposed by the continued action of water, and the salt had been in contact with much water after forming. The results, therefore, confirm Gouy's formula, and indicate that the hydrolysis of Hg_2SO_4 takes place as follows: $3Hg_2SO_4 + 2H_2O = (HgOH)_2Hg_2SO_4 + 2HgHSO_4$. Dilute H_2SO_4 (1 part acid to 6 of water, by volume) was found to prevent this change. Part II. of the paper contains an account of the construction of standard cells by H. S. Carhart [see Abstract No. 2276 (1904)], and a short discussion follows. F. E. S.

1278. *Measurement of Small Differences of Phase.* **W. E. Sumpner.** (Phys. Soc., Proc. 19. pp. 415–428; Discussion, pp. 429–431, April, 1905. Phil Mag. 9. pp. 155–166, Jan., 1905.)—Let the p.d.'s whose phase difference is to be determined belong to independent circuits, and let the circuits be connected so as to have one point from which the p.d.'s are measured in common. Let O be this common point, and OA, OB the two vectors representing the p.d.'s. Then, by measuring the voltages OA, OB, and AB, we determine the triangle of voltages, and hence also the required angle of phase difference θ between OA and OB. For small values of θ, however, and when OA and OB are nearly equal, and their difference nearly equal to AB, the method becomes valueless, as the error may become enormous. In order to overcome this difficulty, the author places a non-inductive shunt across the larger of the two voltages—say OA—and, having connected one terminal of a suitable voltmeter to B, finds by trial a point C in the non-inductive resistance which corresponds to a minimum reading of the voltmeter. Then the ratio of this minimum reading to the unshunted voltage OB gives $\sin\theta$ with accuracy. If, however, the voltages correspond to two portions of the same circuit connected in series, the method is no longer applicable, and the following bridge method may be used. O denoting the junction, and A, B the extreme points of the two portions of the circuit, a non-inductive resistance is connected across AB, and a point C found in it such that a voltmeter connected across OC gives a minimum reading v. Then $\sin\theta = vv_3/v_1v_2$, where v_1, v_2, and v_3 stand for the voltages across AO, OB, and AB respectively. For very small values of v no suitable alternate-current instruments are available, and in such cases the author uses the drastic method of commutation, calculating the r.m.s. value of the voltage from the reading of the delicate direct-current instrument supplied with the rectified voltage. In the *discussion,* **C. V. Drysdale** stated that he had found it advantageous to measure the sine of the phase-difference by using a condenser in series with the pressure coil of a wattmeter, so as to produce a phase displacement of nearly 90° between the voltage and the current in the pressure circuit. A. H.

1279. *Couples Experienced by a Conducting Sphere in a Rotating Field.* **O. M. Corbino.** (N. Cimento, 9. pp. 204–223, March, 1905. Phys. Zeitschr. 6. pp. 227–230, April 15, 1905. Communication from the Phys. Inst. d. kgl. Univ., Palermo.)—On the basis of an early paper of the late H. Hertz (Induction in Rotating Spheres), a theory is here developed for the couple experienced by a sphere in a rotating field. It is shown that the couple will be greatest for one metal of a group for a given frequency of rotation of the field, but for another metal of the group for a different frequency. This agrees with the experimental results as shown in the following table of couples :—

Frequencies.	500	900	2,280	2,900	4,900	6,100
Copper	30	20	16	30	30	30
Tin	17	24	21·8	16	80	54
Bismuth	1	2	3·8	12	40	45

E. H. B.

1280. *Comparison of Inductances.* **A. H. Taylor.** (Phys. Rev. 20. pp. 151–159, March, 1905.)—An alternating current i_1 is sent through a circuit containing a non-inductive resistance r_1, a variable reactance, and at times a standard of self-induction of the variable type. A second alternating current i_2 passes through a separate circuit containing a non-inductive resistance r_2, a variable reactance, and possibly the self-inductance to be compared. In addition each circuit contains a pair of parallel wires bridged with a mercury box, the arrangement constituting a variable rheostat. The currents i_1 and i_2 come from separate coils on the same transformer, the two coils being braided together in order to ensure equality of applied e.m.f.'s. The method of operation is to first obtain a balance between i_1r_1 and i_2r_2 without the inclusion of the inductances in the circuits. The wire rheostats are then adjusted so that the telephone indicates a minimum, and the currents are shifted into phase by varying the reactances. The standard of self-induction is next included in the first circuit, and the adjustment repeated, the setting of the standard being the smallest convenient. Finally, the inductance to be compared is included in the other circuit, and a balance obtained by increasing the value of the standard and by an adjustment of the wire resistances. If ΔS be the change in the reading of the standard, then $L = \Delta S r_2/r_1$. The method described is peculiarly adapted to the step-by-step method of calibrating standards of inductance. F. E. S.

1281. *Variation of Specific Inductive Capacity of Glass with the Frequency.* **A. Broca and Turchini.** (Comptes Rendus, 140. pp. 780–782, March 20, 1905.)—To use Leyden jars for high-frequency currents the capacity determined at low frequencies must be multiplied by a correction factor. The authors have roughly determined this factor by balancing a glass condenser against an air condenser, each being connected to one of the fixed plates of a Henkel electrometer. As a result it is stated that for frequencies of the order 10^6 per sec. the capacity measured by charges of 0·1 sec. duration must be multiplied by 0·5; for those measured by the ordinary alternating current method, by 0·7. [Compare Slaby, Abstract No. 2392B (1904).] L. H. W.

1282. *High-frequency Alternator.* **W. Duddell.** (Phys. Soc., Proc. 19. pp. 431–442; Discussion, p. 442, April, 1905. Phil. Mag. 9. pp. 299–309, March, 1905.)—The author describes a small high-frequency alternator, with which a frequency of 120,000 ∿ was attained. The paper is mainly concerned with an account of the structural details of the alternator and the numerous mechanical difficulties encountered in the attempts to run the machine at a very high speed. The alternator was driven by a figure-of-8 band running between two phosphor-bronze discs, each of the latter being in its turn driven from an electric motor by means of ¼-in. gut bands. A. H.

1283. *Influence of N-rays and of Light upon the Electrical Resistance o Selenium.* **H. Guilleminot.** (Archives d'Él. Médicale, 13. pp. 243–244, April 10, 1905.)—Experiments are briefly described which were made with various sources of *n*-rays (Nernst lamp, tempered steel, &c.) to test whether the *n*-rays have any effect on the resistance of a selenium cell, and also if they produce any change in the diminution of resistance produced by an ordinary light source when acting in conjunction with the *n*-rays. The results were in all cases negative. L. H. W.

1284. *Absolute Electrodynamometer Torque.* **G. W. Patterson.** (Phys. Rev. 20. pp. 300–311, May, 1905. Paper read before the Amer. Physical Soc., April 22, 1904. Ind. Élect. 14. p. 245, June 10, 1905.)—A mathematical paper in which a general formula is derived for an absolute electrodynamometer employing two single-layer coils. The particular instrument considered was designed to take advantage of a simple formula by A. Gray ("Absolute Measurements," &c., vol. ii., part I., p. 275), for the case in which the centres of the axes of both coils have lengths equal to $\sqrt{3}$ times their respective radii. The torque is shown to be practically equal to $4\pi^2 r^2 n n' \mathrm{I}^2 / \sqrt{\mathrm{L}^2 + 4\mathrm{R}^2}$, where r and R are the radii of the suspended and fixed coils respectively, n and n' the corresponding number of turns, L the length of the fixed coil, and I the intensity of the current. In deriving the formula it is assumed that the coils are equivalent to current sheets: justification for this assumption is given at the end of the paper. F. E. S.

1285. *New Form of Oscillograph.* **R. Goldschmidt.** (Electrician, 54. pp. 1038–1039, April 14, 1905.)—A steel needle placed in a magnetic field takes a position coinciding with the lines of force. If, therefore, a small pointed needle is placed between the poles of a strong magnet with the pointed end in a centre mark on one pole, it will stand vertically in the pole face. If brought out of this position the directing action of the magnetism will tend to bring the needle back into its position of equilibrium, and within practical limits this controlling force increases in proportion to the angle of displacement. An alternating current sent through two solenoids placed opposite each other on either side of the needle will cause the latter to oscillate, and if it is light enough its deflection will closely follow the impulses it receives from the current. The top of the needle being polished, a ray of light thrown on it can be received in a rotating mirror or moving film band. In order to make the beam of light describe a curve on a fixed screen a second pair of solenoids are fixed on either side of the needle with their axes at right angles to that of the first pair; they are excited by the same source of alternating current, but are in series with a choking coil, the first pair being in series with an inductionless resistance. Through the influence of both these sets of coils a double movement of the needle is obtained, the movement in the direction of the series of the first coils representing the voltage, while the movement in the direction of the series of the second represents time. The choking coil in the time coil circuit has a double effect: (1) It displaces the phase of the current about 90° behind the phase of the current in the voltage coils. (2) It purifies the current in the time coils by filtering out higher harmonic waves, so that this current is practically a sinusoid, independent of the e.m.f.-wave form. To get deflections on the screen proportional to the time the screen is given a semicircular shape.

E. C. R.

1286. *New Interrupter for Induction Coils.* **A. Turpain.** (Archives d'Él. Médicale, 13. pp. 340–342, May 10, 1905.)—The author describes a form of interrupter devised to secure great rapidity of break. Three metal points plunging into separate mercury cups are mounted on a revolving shaft, and are connected in series so that at breaking contact with the mercury the arc will be split into three, and being consequently shorter will take less time to break. With an interrupter provided with six such points in series the duration of an interruption is only 1/785 sec., and a spark of 18 cm. was obtainable from a coil without condenser, which normally only gave a 12–14 cm. spark with the condenser. In practice a metal-to-metal rotating contact-maker is adapted to employ the above principle.

L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1287. *Physical Interpretation of Couple due to Hysteresis.* **Meller.** (Assoc. Ing. Él. Liége, Bull. 5. pp. 170–185, March, 1905.)—Instead of accounting, as is usually done, for the resisting couple due to hysteresis by an appeal to the principle of the conservation of energy, the author considers how such a couple arises, by plotting the values of the couple corresponding to various positions, in a uniform field, of a thin rod of material exhibiting hysteresis. The curve representing the couple consists of a wavy line which is not symmetrical with respect to the axis of abscissæ (angular displacements of rod from direction of field), the two positive half-waves corresponding to a complete revolution being greater than the two negative ones, and thus accounting for the resultant couple.

A. H.

1288. *Magnets of Hardened Cast Iron.* **B. O. Peirce.** (Amer. Acad., Proc. 40. 22. pp. 701–715, April, 1905. Contribution from the Jefferson Phys. Lab. of Harvard University.)—Early tests indicated that whereas good iron castings as they come from the foundry make most unsatisfactory magnets as far as permanence is concerned, magnets made of castings properly hardened and aged after machining, compare favourably in strength, in permanence, and in the smallness of their temperature coefficients at ordinary temperatures, with the best of tool-steel magnets. Most of the experiments with cast-iron bar magnets were made with pieces 18 cm. long and about 1 cm. in diam. These were usually "relaxed" after hardening by being boiled in water for some time; next they were magnetised to saturation in a solenoid, and then again boiled and "aged" in the usual manner. The resulting magnets were finally tested in competition with a large number of magnets of seasoned tool steel, and their moments were found to differ among themselves less than those of an equal number of the steel magnets made of any one brand; and the average of their moments was rather greater than the average moment of the steel magnets. The temperature coefficient was also less. Some striking hysteresis curves are given illustrating, among other things, the fact that it is possible to make the whole of a massive casting magnetically very hard. F. E. S.

1289. *Action of Currents upon Lag of Magnetisation in a Ferraris' Field.* **R. Arnò.** (Accad. Lincei, Atti, 14. pp. 368–370, April 2, 1905. Elettricista, Rome, 4. pp. 165–166, June 1, 1905.)—In continuance of previous papers [see Abstract No. 1048 (1905)] the author finds that what was true with reference to alternating or interrupted currents or Hertzian waves is also true with reference to continuous currents; that under like conditions the increase of hysteresis loss (if any) is notably smaller or the diminution (if any) notably greater with continuous currents than with the other currents or waves; that under conditions where continuous currents give no change in the hysteresis, alternating or interrupted currents or Hertzian waves cause an increase in it, and conversely where these cause no change in it continuous currents cause a diminution in it. Variations in the strength of the various currents used showed that: (1) with rotatory fields powerful enough always to show a diminution in the lag of magnetisation this diminution is greater the stronger the secondary magnetic field due to the current; (2) with weak rotating fields the lag of magnetisation increases to an extent which grows with progressive increase in the secondary field up to a maximum and then itself falls away; and (3) with weak rotatory fields there is one relative value of the secondary field which gives a maximum increase, and another which gives neither increase nor decrease in the hysteresis. A. D.

1290. *Effect of Electric Oscillations on Magnetism.* **L. H. Walter.** (Electrician, 55. pp. 83–84, May 5, 1905.)—The author reviews the recent papers on this question, and draws attention to the fact that there has been considerable disagreement between the views of various experimenters. One source of confusion is the use of the term hysteresis in two senses—(i.) as a lag, and (ii.) as a loss; and it is pointed out that the hysteresis (lag) may be decreased while at the same time the hysteresis (loss) may be increased by the effect of a high-frequency oscillating field. Then, again, confusion has arisen owing to writers not being explicit as to whether the cyclic flux or the moving band form of detector has been employed, and in several cases the experimenters have not understood that an exceedingly weak intensity of magnetisation of the core must be employed. Later papers on the discussion of Arnò's paper are also reviewed. [See Abstracts Nos. 1047 and 1048 (1905).] S. G. S.

1291. *Critical Points of Heusler's Aluminium-Manganese Alloys.* **E. Take.** (Deutsch. Phys. Gesell., Verh. 7. 7. pp. 133–145, April 15, 1905. Phys. Inst., Marburg, Feb., 1905.)—Describes the magnetic properties of these magnetic alloys of non-magnetic constituents, and gives a preliminary account of their critical points as determined by magnetic ballistic measurements and by dilatometry. Experiments with various alloys are described and the ballistic curves obtained on gradual heating and cooling are given. The most striking result is the effect of repeated heating in altering the magnetic susceptibility and the position of the change-point; the magnetic properties of the alloys always diminished after repeated heating, and apparently no form of heat-treatment could restore the initial state. The part played by lead in these phenomena is investigated by comparisons between two pairs of alloys differing only in regard to lead contents, and the conclusion is indicated that the effect of the lead in improving the magnetic properties of these alloys is lost after heating and cooling a few times. Cooling curves and microscopic examination of these alloys are in progress in the hands of other workers. [See also Abstract Nos. 622 and 623 (1904).]

W. Ros.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1292. *Measuring the Dose in Applications of Static Electricity.* **L. Benoist.** (Archives d'Él Médicale, 13. pp. 257–263, April 10, 1905. Comptes Rendus, 140. pp. 1106–1107, April 17, 1905.)—The electrodensimeter of the author is described, consisting of a graduated electrometer reading directly in "franklins"—the designation employed by the author for the c.g.s. unit of quantity of electricity (1 franklin $= \frac{1}{3} \times 10^{-9}$ coulomb). The density is measured in franklins per sq. cm. The procedure employed in taking measurements is indicated.

L. H. W.

1293. *The Factor "Distance" in Radiotheraphy.* **J. Belot.** (Archives d'Él. Médicale, 13. pp. 245–256, April 10, 1905.)—From geometrical considerations the author arrives at the conclusion that the emission point of the Röntgen rays should be placed at a distance from the surface to be treated at least twice as great as the largest dimension of that surface, for the action to be uniform. Practical examples are given.

L. H. W.

REFERENCES.

1294. *New System of Units.* **Lwowitch.** (Assoc. Ing. Él. Liége, Bull. 5. pp. 142–149, March, 1905.)—The author discusses a system of units in which the unit of length and that of velocity are taken as the fundamental units. He points out that such a system presents certain advantages, the dimensions of the electrostatic units and those of the corresponding electromagnetic ones becoming identical.

A. H.

1295. *Glow Discharge.* **K. Przibram.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. pp. 1491–1507, Dec., 1904. From the Inst. f. theoret. Physik an der k.k. Univ. in Wien.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1296. *New Conception of the Chemical Atom.* **P. de Heen.** (Acad. Roy. Belg., Bull. pp. 285–289, 1904.)—Defining the atom as the constant quantity of energy possessed, under constant conditions, by a given volume of an elementary substance in the gaseous state, and taking this amount of energy as unity, the atomic weights will be the relative weights of the elements containing this constant quantity of energy. An atom may be regarded as physically composed of rotating fibres of infinite length, the number of which is at least as great as that of the lines of the spectrum of the element, and each of which has a definite energy of rotation. In combination between molecular proportions of two monatomic univalent gases, the gyrostats of fibres would join two by two and the volume of the product would be one-half that of the total volume of the two reacting gases. This conception may be extended to combination between diatomic and polyatomic gases, where it may be supposed that the two gyrostats become iodynamic by some external influence and the electrons liberated from each gyrostat form an intermediate chain which exerts a tension and eventually brings the gyrostats into the tangential position. The reactivity of a substance will hence depend on the facility with which it becomes iodynamic, and if the orientation of its electrons corresponds with that of the kathode rays, the subtance will be electro-negative, whilst if the orientation is the converse it will be electro-positive. This idea is more simple to apply if it is supposed that all gases under the same conditions possess the same length of fibre, *i.e.*, have the same number of molecules, and that each atom consists of a single, infinitely long, unique, gyrating fibre having distributed about its axis as many twists of different diameters and tensions as there are lines in the spectrum of the element. A molecule may similarly be regarded as a compound fibre or cable composed of atomic gyrostats, some of which may be left and others right. In the solid form of a compound the cable is rolled on itself, and the nature of its optical activity will depend on the direction in which the cable is coiled.

T. H. P.

1297. *Molecular-weight Determination by the Rise of Boiling-point in Kathode-ray Vacuum.* **F. Krafft** and **P. Lehmann.** (Ber. Deut. Chem. Gesell. 38. pp. 242–253, Jan. 21, 1905.)—The authors have previously shown that the boiling-point of high molecular liquids in the vacuum of the kathode light depends on the height of the column of vapour above the liquid, and also on the molecular weight of the substance [see Abstract No. 2626 (1904)]. In the present paper improvements in the apparatus are described, one of the principal ones being an arrangement by which the thermometer can be moved, so that the temperature at any position, from immersion in the liquid to the very top of the vapour column, can be read off. The work performed by each layer of vapour in raising up that above it causes an absorption of heat, so that in the case of mercury the temperature falls from 174° in the liquid to 152° at the top of a column of the vapour 195 mm. high. The difference of these two temperatures is given for various substances: for palmitic and lauric acids and mercury, the values (28·4°, 22·2°, and 22° respectively) are exactly proportional to the molecular weights. That this relationship holds generally is shown by the values obtained for a number of other substances. The method can be used for metals, quartz vessels being employed. Cadmium exhibits a fall of 5° for a column of vapour 80 mm. in height, zinc one of 3°, and lead one of 2–3°, which values are proportional to the corresponding molecular weights. T. H. P.

1298. *Atomic Weights of Hydrogen and Nitrogen and their Accuracy.* **A. Leduc.** (Comptes Rendus, 140. pp. 717–718, March 13, 1905.)—The number given by Guye [see Abstract No. 2035 (1904)] for the atomic weight of hydrogen, namely, 1·00765, and that given by Berthelot—1·0075—are in good agreement with the value, 1·0076, previously obtained by the author. The International Atomic Weight Commission gave the value 14·04 for the atomic weight of nitrogen as late as 1904. The author has, however, found the number 14·005, and the values obtained by Guye are 14·007, 14·0085, and 14·012. It is hence concluded that the value must be less than 14·01.

T. H. P.

1299. *Specific Volume as a Criterion of Chemical Combination in the Case of Alloys.* II. **E. Maey.** (Zeitschr. Phys. Chem. 50. pp. 200–218, Dec. 16, 1904.)—Determinations of density as a function of composition in the case of various (solidified) binary melts. So long as the "alloy" only consists of a mechanical mixture of the two constituents its specific volume can be calculated by the "mixture-law" from the specific volumes of its components. Departures from this behaviour indicate compounds or solid solutions. The author's results indicate the existence of the following chemical individuals (in certain cases the actual composition is doubtful) : Sb_3Zn_2, Sb_2Cd_3, $SbAg_3$, $SbCu_3$, $AgZn_4$, $AgCd_2$ (or $AgCd_3$), $CuCd_2$, AgHg. The existence of most of these compounds has been shown previously by other investigations.

F. G. D.

1300. *Electrical Conductivity of Liquid Ammonia Solutions.* II. **E. C. Franklin** and **C. A. Kraus.** (Amer. Chem. Soc., Journ. 27. pp. 191–222, March, 1905.)—The authors have previously determined the molecular conductivity of salts in liquid ammonia at its boiling-point, —33° [see Abstract No. 1711 (1900)]. They now extend their investigations to a large number of other substances and to more concentrated solutions, the apparatus previously employed being modified. The compounds examined by them are : Formamide, chloracetamide, cyanacetamide, phenylacetamide, benzamide, thiobenzamide, phthalimide, cyanamide, sulphamide, nitramide, methylnitramine, nitroguanidine, urethane, nitrourethane-ammonium, mercurosuccinimide, sodionitromethane, tetranitromethane, trinitrobenzene, trinitraniline, water, and the following salts: Potassium, mercuric, silver, zinc and aurous cyanides ; lithium, sodium, potassium, thallium, silver and barium nitrates ; sodium and ammonium chlorides, bromides and iodides ; ethyl- and diethylamine hydrochlorides and silver iodide. The results obtained show that the number given in the literature for the specific conductivity of liquid ammonia at its boiling-point (— 33°) is too high, the true value being less than $0{\cdot}01 \times 10^{-6}$ Kohlrausch units. The acid amides in ammonia solution conduct electricity, the conductivity being in some cases small, although some substituted acid amides have conductivities equal to those of monovalent salts. Certain nitro-compounds, both aromatic as well as aliphatic, are very good conductors, their solutions being in some cases strongly and characteristically coloured.

The cyanides of the heavy metals and of cyanacetamide, when dissolved in ammonia, exhibit in the more concentrated solutions a decrease of molecular conductivity with the dilution; with increasing dilution the conductivity passes through a minimum and then increases with the dilution in the manner characteristic of salts in general. The uni-univalent salts show a wide variation in conductivity and degree of ionisation with the dilution. The results are given in the form of tables and curves. [See Abstract No. 232 (1905).] T. H. P.

1301. *Water of Constitution and of Crystallisation.* **W. W. Coblentz.** (Phys. Rev. 20. pp. 252–258, April, 1905.)—The curve of the infra-red absorption of brucite, $Mg(OH)_2$, shows that the hydroxyl-group, to the resonance of which numerous phenomena have been ascribed by different investigators, cannot be very instrumental in causing the absorption bands of water; from its dissimilarity to the water curve, it is concluded that water of constitution is in a different condition from water of crystallisation. The curve for selenite, $CaSO_4 + 2H_2O$, shows, on the other hand, a striking resemblance to that for water. T. H. P.

1302. *Melting-curve of* $Cd(NO_3)_2, 4H_2O$. **N. A. Poushine.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 8a. pp. 1115–1116, 1904.)—The author investigates the determination of the melting temperature of $Cd(NO_3)_2, 4H_2O$ in terms of the pressure, which latter, in connection with his experiments, was raised to about 3,000 atmospheres. The results are recorded in the following table:—

Pressure (in kg. per. sq. cm.).	Melting-point.	(Pressure in kg. per. sq. cm.).	Melting-point.
1	58·7°	1,388	69·15°
236	60·5	1,675	71·0
471	62·2	2,400	75·1
847	65·2	2,900	78·1
1,093	67·1		

The direction of the curve is controlled by the equation—

$$t = 58{\cdot}7^\circ + 0{\cdot}00813p - 0{\cdot}0000005p^2,$$

whence it is inferred that when the pressure reaches about 8,000 kg., the melting-curve will reach its maximum, and the magnitude dI/dp will pass through zero and become negative. There were further determined by experiment the figures for Δv with different pressures (to about 2,000 atmospheres), the results being given below (weight of salt 98 gm.):—

Temperature.	Pressure (kg. per sq. cm.).	Δv (in mm.^{3}).
61·0°	431	44·0
68·0	1,320	37·3
72·0	1,993	33·3

In order to compare the figures dT/dp, as found by experiment, with those that might be expected on the Clausius-Clapeyron formula $dT/dp = T\Delta v/Rp$, the crystallisation heat of the salt was determined at 40°, and was found to be equal to 26·3, the values of $T\Delta v/R$ coming extremely near to the values for dT/dp as found by experiment. A. G.

1303. *Reduction of Mercurous Chloride by Silver.* **J. N. Brönsted.** (Zeitschr. Phys. Chem. 50. pp. 481–486, Dec. 30, 1904.)—As comparatively few spontaneously occurring endothermic reactions are known, the author has studied the reduction of mercurous chloride by silver. The method employed was determination of e.m.f. of the cell Ag/AgCl — KCl — HgCl/Hg. At 15° the e.m.f. of the cell is 0·0437 volt, the current flowing in the cell from silver to mercury. It is accompanied by a heat absorption of 1,920 cal. The numbers calculated by means of the Helmholtz formula from the temperature coefficient of the e.m.f. gave concordant results. The temperature coefficient of the heat evolution is negative, and the absorption of heat therefore increases with rise of temperature. A. F.

1304. *Influence of Admixtures on the Critical Phenomena of Simple Substances and the Explanation of Teichner's Experiments.* **J. E. Verschaffelt.** (Konink. Akad. Wetensch. Amsterdam, Versl. 13. pp. 508–516, Jan. 5, 1905. Proc. 7. pp. 474–482, Jan. 25, 1905.)—The author here considers theoretically the effect of admixtures on the critical phenomena of a substance, in view of the fact that several investigators have expressed their doubts as to the validity of the theories of Andrews and van der Waals. He shows how slight admixtures (say $\frac{1}{1000}$ mol.) may cause very considerable differences in the density in a critical-point tube. He then reviews critically the experiments of Teichner [see Abstract No. 1099 (1904)], and shows how, qualitatively at least, the deviations from Andrews' theory can be explained on the assumption of traces of impurity. A. F.

1305. *Cryoscopy of Solutions in Hydrocyanic Acid.* **Lespieau.** (Comptes Rendus, 140. pp. 855–857, March 27, 1905.)—A cryoscopic examination of solutions of absolute alcohol, chloroform, benzene, water, trichloracetic acid, sulphuric acid, potassium iodide, and potassium nitrate, in liquid hydrocyanic acid, shows that the molecular depression for the first six is practically constant, being about 19, while that of the two last is approximately double this. It is evident, therefore, that although sulphuric and trichloracetic acids are strongly dissociated electrolytically by water, they are not sensibly so in hydrocyanic acid solution, notwithstanding the higher dielectric constant of the latter solvent, thus confirming Kahlenberg's conclusion [see Abstract No. 525 (1903)] that the relationship between dielectric constant and dissociating power of the solvent, suggested by Nernst, does not exist. The increased molecular depression found with solutions of KI and KNO_3 indicates the almost complete dissociation of the salts into two ions, and is in marked contrast to Kahlenberg's results that hydrocyanic acid solutions of these salts were better conductors than aqueous solutions of the same concentration. W. H. Si.

1306. *Melting- and Transition-points of Some Salts.* **K. Hüttner** and **G. Tammann.** (Zeitschr. Anorg. Chem. 43. 2. pp. 215–227, Jan. 25, 1905. Inst. für anorg. Chemie der Univ., Göttingen.)—The determinations were made by obtaining cooling-curves, *i.e.*, plotting temperature (as measured by a le Chatelier thermo-element) against time. From these curves approximate values can also be found for the ratio of heat evolved on solidification to heat evolved on transformation. The galvanometer used was calibrated to give readings corresponding to the gas thermometer, by taking 630·6° and 1,064° as the melting-points of antimony and gold respectively (Holborn and

Day's values). The following table gives the temperature-points observed (T = transition-point) : LiCl, 605–607 ; NaCl, 810 ; NaBr, 748–749 ; NaI, 664 ; KBr, 740 ; KI, 680 ; RbCl, 712–713 ; Li_2CO_3, 734–735 ; Na_2CO_3, 853, 450 (T) ; K_2CO_3, 894, 410 (T) ; Li_2SO_4, 859, 575 (T) ; Na_2SO_4, 897, 235 (T) ; K_2SO_4, 1,074, 587 (T) ; Rb_2SO_4, 1,074, 657 (T) ; Cs_2SO_4, 1,019 ; Na_2MoO_4, 692, 620–605 (T), 410–380 (T) ; K_2MoO_4, 926, 200 ? (T) ; Na_2WO_4, 698, 570 (T) ; K_2WO_4, 906, 300–200 (T). F. G. D.

1307. *Experiments with an Electro-thermic Muffle Furnace.* **F. A. J. FitzGerald.** (Electrochem. Ind., N.Y. 3. pp. 135–139, April, 1905.)—This paper deals exhaustively with a series of experiments made with a furnace consisting of five muffles, each 38 cm. long, 23 cm. wide by 16 cm. high, placed side by side in an inverted position. The muffles were embedded in a resistor of amorphous silicon carbide, the whole being contained in a brick trough. Details are given of all dimensions, and of the method of construction of the whole apparatus, together with illustrations. The heat efficiency of the furnace, starting cold, and finishing with a muffle heat of about 1,100° C., was about 50 to 60 per cent. Ordinary muffles were found unsuitable, and the author suggests silico-carbide as the most suitable material for constructing the muffles for use in such a furnace, where the great advantage to be obtained is rapidity of heating by pushing the temperature of the resistor to a high degree. J. L. F. V.

1308. *Structure of Tempered Steel.* **W. Kurbatoff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 37. No. 2. pp. 169–180, 1905.)—The author has applied the method of colourations [see Abstract No. 891 (1905)] to the examination of a steel containing 1·9 per cent. carbon, 0·02 per cent. sulphur and phosphorus, and 0·02 per cent. manganese. Three series of experiments were made : (1) The steel was heated to fusion and tempered ; (2) it was tempered just below, at, and just above the transition period ; (3) one end of a piece of the steel was heated red-hot while the other end was placed in water ; the whole was then tempered and examined microphotographically. Most of the results obtained are similar to, or identical with those already communicated [Abstract No. 645 (1905)]. The author is of opinion that the different constituents of steel can crystallise together as isomorphous mixtures, and can form solid solutions in one another ; hence very many transitional forms between troostite, sorbite, martensite, austenite, &c., have been observed by him under suitable conditions. With reference to sorbite (to which special attention was paid in the inquiry), the author finds that tempering at 300°–400° gives a uniform ground of sorbite cut through by plates of cementite ; tempering from 400°-800° gives all transitional forms from sorbite to pearlite. D. H. J.

1309. *Further Observations on Slip-bands.* **W. Rosenhain.** (Roy. Soc., Proc. 74. pp. 557–562, April 10, 1905.)—A small strip of soft iron, one face of which has been polished, and which has then been overstrained in tension, is thickly electroplated with copper and cut longitudinally at right angles to the polished face ; this section, upon examination, shows the slip-bands in the form of slight serrations of the boundary line between iron and copper, confirming the early view of Ewing and the author as to the crystalline nature of slip-bands. The method for polishing up to a sharp edge can be usefully applied to the study of fractures, &c. F. R.

1310. *Cooling during Quenching of Steel.* **P. Lejeune.** (Soc. d'Encouragement, 107. Rev. de Métallurgie, pp. 299–311, April, 1905.)—The author studied the cooling of steel during quenching, by means of apparatus due to le Chatelier, which acts somewhat similarly to that of Saladin [see Abstract No. 1279B (1904)]. He finds that quenching in a small bulk of mercury, *e.g.*, as practised for surgical instruments, is slower than in water. The maximum rate of cooling from the quenching temperature (about 850° C.) is indicated between 500° and 600°, but occurs at a much earlier stage in water and mercury quenching than with some other liquids; the thermo-couple, however, is embedded in the specimen. Using mixtures of water and glycerine, it was found that the duration of quenching varied in a somewhat similar way to the viscosity. The following figures show this variation; the volume of liquid in each case is 2 litres: glycerine per cent., by weight, 2, 10, 20, 50; relative viscosity (water = 1) 1·05, 1·18, 1·33, 1·6. The temperature fell from 700°–100° in 6·5, 8·2, 10·3, 11·3 sec. respectively. The specific heat of the liquid affects the duration of cooling. Alcohol and xylol were used, and a comparison was also made between a bath of oil and one of equal viscosity consisting of 90 per cent. glycerine in water; 27·5 and 11·3 sec. respectively were required for the fall of temperature from 700° to 150°. The shape of the cooling curves is affected by ebullition of the liquid and by the occurrence of a jacket of vapour about the specimen. The latter were in the form of cylinders of equal diam., and the duration of quenching would seem to vary less rapidly than the length and more rapidly than the ratio of volume to surface. F. R.

1311. *Gold-Thallium Alloys.* **M. Levin.** (Zeitschr. Anorg. Chem. 45. 1. pp. 31–38, April 27, 1905. Communication from the Inst. f. anorg. Chem. d. Univ., Göttingen.)—Determinations of the freezing-points and retardation-points in the cooling-curves of gold-thallium alloys have been made, and a temperature concentration diagram drawn. The diagram shows a well-marked eutectic point at 131°, corresponding to an alloy containing 27 per cent. Au. There is no indication of the existence of any definite compounds between the two metals, and the examination of micro-sections of the ingots of the alloys confirms this view. The only abnormal feature is found in sections of the alloy containing 25 per cent. Au, in which primary crystals of both gold and thallium were found; these are explained as being due to surfusion. A retardation in the cooling-curve of pure thallium was, however, found at 225°, and this leads the author to introduce a horizontal line into the diagram, corresponding to an allotropic change in the thallium; he also introduces another similar line at 180°, corresponding to the sudden change in the viscosity of thallium found at that temperature by Werigin, Lewkojeff, and Tammann. W. Ros.

1312. *Red Colloidal Gold Solution obtained by means of Carbon Monoxide.* **J. Donau.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 79–84, Jan., 1905. From the Laborat. f. allgem. Chemie an der k.k. tech. Hochschule in Graz.)—When carbon monoxide is passed into a gold solution the salt is reduced and the gold remains in the colloidal state. In small concentrations (ca. 0·002 per cent. gold) the colour of the solution is bright red, and does not exhibit opalescence. More concentrated solutions (ca. 0·05 per cent. gold) are dark red and show opalescence when viewed from above. The solutions appear to be quite stable so long as the presence of electrolytes is avoided. These solutions differ from those obtained by Zsigmondy when placed in an electric circuit. They behave like the solutions described by Blake [see Abstract No. 688 (1904)], the gold wandering away from the two electrodes and collecting in the middle. A. F.

1313. *Combination of a Solvent with the Ions.* **J. L. R. Morgan** and **C. W. Kanolt.** (Amer. Chem. Soc., Journ. 26. pp. 635–637, June, 1904.)—On electrolysing a solution of silver nitrate in a mixture of pyridine and water, or one of copper nitrate in a mixture of alcohol and water, it is found that the concentrations of the organic non-electrolyte at the electrodes undergo change. From this the authors conclude that in all solutions, whether mixed or unmixed, the ions retain a certain amount of the solvent, with which they form complex ions. The forms taken by the law of mass action under the various possible combinations are investigated. When the complex ions contain only one simple ion the equilibrium is in accordance with Ostwald's dilution formula. If two ions of one kind combine with the solvent to form one complex ion, that is, if one ion condenses while the other does not, or if both ions condense, the equilibrium is given by van't Hoff's form of Rudolphi's dilution formula. Possibly the complex ions themselves decompose, so that the velocity of migration of the ions changes with the dilution. T. H. P.

1314. *Electrolysis with Alternating Current.* **C. Rossi.** (Indust. Chim. 6. pp. 333–335, Nov. 26, 1904.)—In electrolysis with alternating currents, reactions often take place owing to the fact that the electrodes are not strictly reversible, and, under some circumstances, rapidly form undecomposable complex ions. When a solution of potassium chlorate acidified with sulphuric acid is electrolysed between copper and iron electrodes by means of an alternating current, the copper electrodes become coated with cuprous chloride and the solution is found to contain copper and chlorine, while a bluish-green basic copper chlorate, $Cu(ClO_3)_2, 3Cu(OH)_2$, is deposited on the electrodes and on the bottom of the vessel. When a direct current is used cuprous chloride and a certain amount of basic chlorate and chloride form on the anode, while a mixture of cupric hydroxide, metallic copper, and chloride is precipitated from solution; the solution, however, contains no copper, but only potassium chloride and chlorate. The copper goes into solution as the cuprous ion, which reduces the chlorate and is precipitated by the kathodic potassium hydroxide. If the potassium chlorate is replaced by sodium chloride, very little copper goes into solution when an alternating current is employed, because only diffusion and convection take place, and there is no reaction to remove the copper ions in solution from the influence of the opposite current. Similar phenomena are obtained with iron electrodes. T. H. P.

1315. *Crystallisation of Tin and Zinc from Electrolysed Solutions.* **A. W. Saposchnikoff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 37. No. 2. pp. 153–156, 1905. From the Chem. Lab. of the Michael Academy of Artillery.)—For a microphotographical study of its crystallisation tin may be separated from stannous chloride solution as follows. A clean glass plate is placed on two glass rods lying in a dish, and the stannous chloride solution is poured over the plate; a piece of tin in contact with the glass plate serves as anode, and a copper wire 10–15 cm. away as kathode; on allowing a current from a couple of accumulators to pass, a branching crystallisation starts at the point where the copper wire touches the glass, and spreads over the latter.

The liquid may be drawn off and the plate washed, dried, and varnished (to protect the preparation). Zinc may be well crystallised from solutions of the chloride and sulphate in the same way; the other metals have so far not given satisfactory results. D. H. J.

1316. *Change of Electrolytic Dissociation with Change of Temperature.* **A. Campetti** and **M. Nozari.** (Accad. Sci. Torino, Atti, 40. Nos. 2 and 3. pp. 155–163, 1904–5.)—Determinations of electrical conductivity (for ascertaining the degree of electrolytic dissociation) are very numerous for the ordinary temperature, but very limited for higher temperatures; the authors, therefore, by the Kohlrausch telephone method, measured the conductivity of solutions of sodium and potassium chlorides between the temperatures 20° and 90°, and with concentrations ranging from binormal to one-thousandth normal. The data obtained show that (1) for solutions (not excessively dilute) of sodium chloride and of potassium chloride the degree of electrolytic dissociation diminishes with increase of temperature; (2) the heat of dilution of these solutions does not represent the heat due to electrolytic dissociation, and therefore (3) it is necessary to assume in such solutions the probable existence of molecular complexes of solvent and solute. D. H. J.

1317. *Theory of the Electrolytic Rectifier.* **S. R. Cook.** (Phys. Rev. 20. pp. 312–321, May, 1905. Phys. Lab., Cornell University.)—The author gives an account of a more extensive research on lines similar to the work previously described [see Abstract No. 1144 (1904)], but with improvements in detail. The measurements desired were: The direct e.m.f. applied; the counter-e.m.f. of the electrolytic cell immediately (with a shorter interval) after the current is broken; and the current through the polarised cell. The e.m.f.'s were measured by charging a condenser from the cell and discharging through a galvanometer. Tables are given of these values. The author was desirous of proving that all the apparent resistance was due to a counter-e.m.f. instead of only 85 per cent. as previously found, and for this purpose the decay of the counter-e.m.f. with time was investigated so that the maximum could be computed. The decay curve shows that 0·01 sec. after rupture the counter-e.m.f. *does* account for all the apparent resistance. The electrolytic resistance (including resistance of electrolyte and ionic resistance of film) increases at first with the p.d., then suddenly decreases and again increases to a second maximum, and finally falls off rapidly (at critical p.d.) as crystallisation of the film exposes the charged metallic surface. L. H. W.

1318. *Mass Analysis of Muntz's Metal by Electrolysis.* **J. G. A. Rhodin.** (Faraday Soc., Trans. 1. pp. 119–133; Discussion, pp. 133–135, May, 1905. Electrician, 54. pp. 664–666; Discussion, p. 666, Feb. 10, 1905. Abstract.)—The author gives complete details of the method devised by him for obtaining rapid analyses of numerous samples of Muntz metal. The requirements were in the main analyses of some seventy-five samples in 24 hours, for copper, the results being wanted within about 12 hours, and the accuracy to be within ± 0·1 per cent. The author adopted the electrolytic method, using platinum gauze anodes and kathodes of special design, and he supplies all the data requisite for carrying out the installation. The article is illustrated. J. L. F. V.

REFERENCES.

1319. *Solubility of Calcium Sulphate in Solutions of Other Salts.* **F. K. Cameron** and **B. E. Brown.** (Journ. Phys. Chem. 9. pp. 210–215, March, 1905.)—In solutions of NH_4Cl or NH_4NO_3 of gradually increasing strength the solubility of calcium sulphate (presumably $CaSO_4 . 2H_2O$) is first increased and then diminished (Temp. 25° C.). Values are given. F. G. D.

1320. *Thermochemical Investigations on Strychnine and Brucine.* **Berthelot** and **Gaudechon.** (Comptes Rendus, 140. pp. 753–761, March 20, 1905. Annal. Chim. Phys. 5. pp. 145–165, June, 1905.)—Experiments in the calorimetric bomb are described from which the molecular heat of combustion of strychnine, its heat of formation and heats of reaction are obtained; values are given also for brucine. T. H. P.

1321. *Heat of Formation of Hydride and Nitride of Calcium.* **A. Guntz** and **H. Basset, Jr.** (Comptes Rendus, 140. pp. 863–864, March 27, 1905.)—The heats of formation obtained are: Calcium hydride, 46·2 Cal.; calcium nitride, 112·2 Cal.; and calcium oxide, 151·9 Cal., the last being 20·4 Cal. higher than the value found by Thomsen. W. H. Si.

1322. *Transformation of Secondary into Principal Plaits and the Reverse.* **J. D. van der Waals.** (Konink. Akad. Wetensch. Amsterdam, Versl. 13. pp. 625–630, April 5, 1905. Proc. 7. pp. 621–626, April 19, 1905.)—The author discusses the conditions under which the primary and secondary plaits merge into one another, and illustrates the change by figures. In conclusion he gives (px) diagrams for coexisting phases, and develops the differential equations under the supposed conditions. H. H. F. H.

1323. *Periodic Contact Catalysis.* II. **G. Bredig** and **E. Wilke.** (Heidelberg Natur.-hist. med. Ver., Verh. 8. pp. 165–181, 1904.)—An investigation of the conditions under which the action between hydrogen peroxide and mercury in contact is periodic, the pulsations being also studied in a manner similar to that used by Ostwald. T. H. P.

1324. *Kinetics of the Hydrolysis of Benzene Methyl Sulphonate.* **A. Praetorius.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2b. pp. 941–974, Oct., 1904. From the I. chem. Laborat. der k.k. Univ., Wien.)—As Wegscheider has shown, the esters of the aromatic sulphonic acids are hydrolysed by water, the velocity-equation being of the first order in dilute solutions. Hydrogen ions do not increase the velocity of this reaction. Extremely careful measurements with the methyl ester of benzene sulphonic acid in dilute aqueous solution at 25° are communicated in this paper and fully confirm the above statements. F. G. D.

1325. *Melting-point Curves of Mixtures of Anthracene and Picric Acid.* **R. Kremann.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2b. pp. 1085–1090, Nov., 1904. From the Chem. Inst. der Univers. Graz.)—Although a compound of these two substances is formed, this fuses with decomposition and deposition of anthracene. [See also Abstract No. 2245 (1904).] A. F.

1326. *Application of the Principle of Watt to the Dissociation of the Carbonates of Lead and Silver.* **A. Colson.** (Comptes Rendus, 140. pp. 865–867, March 27, 1905.)—The decompositions of lead and silver carbonates are reversible if there is a little water vapour present. If, on the other hand, the carbonates are quite dry, the CO_2 produced does not recombine. The water vapour produces a catalytic acceleration of both dissociation and recombination. F. G. D.